ORTHOPTERA FROM NORTHERN FLORIDA.

BY JAMES A. G. REHN AND MORGAN HEBARD.

The material treated in this paper was collected by the authors between the 10th and 20th of August, 1905. The localities at which collecting was done are treated below in detail. The material has been divided between the collection of the Academy and the collection of the junior author, all types remaining in the latter. The number of specimens examined is 1,356, representing eighty-nine species, of which four are described as new.

LOCALITIES.

Jacksonville, Duval County. The few specimens taken at this locality were captured in a weed-covered lot near the railroad station, among the shrubbery in Hemming Park, on the street, on the Clyde Line wharf, and at a suburb on the St. John's River known as Riverside.

Pablo Beach, Duval County. This small community, existing almost entirely as a summer resort, is situated on the Atlantic coast of the peninsula, seven miles south of the mouth of the St. John's River and eighteen miles east of Jacksonville. The characters of the regions or zones at this locality at which collecting was carried on are quite varied, and a detailed description is necessary.

The beach proper is very wide along this part of the coast, the angle of its slope is very slight, and its boundary formed by rather irregular sand dunes, some of which are thirty or more feet high. The upper slopes and tops of the dunes are covered with a growth of scrub or saw palmetto (*Serenoa serratula*). These dunes while irregular in height are very regular in the line of their steep barrier-like seaward slope.

Landward the dunes drop into a level tract of sandy barrens varying from one to two or more miles in width and extending for a considerable distance up and down the coast. The barrens are thickly covered with saw palmetto (*Serenoa serratula*) and several other low plants, making everywhere a low but thick tangle. While usually dry in character this open saw-palmetto region has numerous wet spots, some with the sand little more than damp and others with considerable areas of true marsh with some of the accompanying vegetation. About these marshy spots are frequently bushes ten or fifteen feet in height, which are the only vegetation of any height in the extensive "palmetto scrub," as this region is called in the following pages.

Farther north along the beach, and in a few localities about Pablo Beach, the ground immediately west of the shore dunes is covered with a dense tangle of numerous varieties of bushes, the majority of which are about ten feet high. It was in these bushes that *Cyrtophyllus* was abundant.

Inland the broad tract of open country is bordered by another area, bearing a scattering growth of pine and an occasional cabbage palmetto (*Sabal palmetto*) growing on marshy soil, this zone being distinctly narrower than the preceding one.

West of the scattered pine belt is a strongly marked zone of "hammock" land, the arborescent species of which are varied but in a large part cabbage palmetto, all very closely placed and woven together with numerous lianas. This zone is almost impenetrable, is about a mile in width and extends for miles up and down the coast, in most places being on higher ground than the immediately surrounding country.

Pablo Creek flows north on the west side of the hammock, emptying into the St. John's near Mayport, and extensive dependent marshes are present on the east side of the stream, between it and the "hammock" land. In little scattered areas here are marshy pine woods, but in no place in this creek marsh was the collecting found to be good.

Still farther inland, west of the stream and beginning at the western edge of the creek marsh, is the extensive long-leaf pine (*Pinus palustris*) forest which stretches westward to the St. John's.

Access to these various zones was gained chiefly by means of a railroad embankment, along the sides of which, in wet drains overgrown with grass and in cleared grass and weed covered right-of-way, much good collecting was done.

San Pablo, Duval County. This locality is situated in the long-leaf pine forest three miles west of Pablo Beach. The undergrowth in the woods here was dry and chiefly wire-grass. This situation was the nearest to Pablo Beach at which typical pine woods collecting could be secured. The Orthoptera taken at this locality showed a considerable affinity to that taken in the open saw palmetto at Pablo Beach.

Gainesville, Alachua County, is situated in northern Florida, sixty-two miles in an air-line southwest of Jacksonville. The region is that of the long-leaf pine (*Pinus palustris*) and forests of this noble tree surround the town, although large areas have been cleared and are either under cultivation or grown up as characteristic Southern "old fields." Excellent collecting was found here in the undergrowth in the pine woods, the gallberry bushes, scrub oaks and wire grass affording excellent cover. In several flooded sink-holes in the pine woods we found among the surrounding marsh grasses such moisture-loving forms as *Leptysma*, *Stenacris* and *Eotettix palustris*. Owing to the fact that our stay was limited to a day and a half, the collection from this locality doubtless does not include many species which might be found there, but the results for that length of time were extremely satisfactory.

Cedar Keys, Levy County. On a small coquina islet in the northern Gulf of Mexico, a short distance from the Floridan mainland, is the town of Cedar Keys. The town is on one of a number of keys to which collectively its name is applied. The surface of the main key is slightly rugged and the soil poor, owing to the almost bare coquina rock. Outside of the village scattered groves of short-leaf pine, numerous palmettos and an undergrowth of waist-high bushes comprise the principal floral features of the dry land. There are many large Indian shell-mounds on the key, and on them the forest growth is thickest. The key is indented by many lagoons and bays, along the edges of which are many wide areas of salt-marsh grass in which Orthoptera was exceedingly abundant.

Palatka, Putnam County. The material from this locality was taken in the town proper.

St. Augustine, St. John County. The few specimens from this locality were taken in the hotel grounds in the evening.

FORFICULIDÆ.

Anisolabis maritima (Bonaterre).

A pair of this species was taken from under rubbish on a lot in the city of Jacksonville, August 11.

Anisolabis annulipes (H. Lucas).

This widely distributed species was taken at three localities: Jacksonville, August 11, in company with *A. maritima*, one male; Pablo Beach, August 11 (marsh), one female; Cedar Keys, August 15, one female.

Labia burgessii Scudder.

Three females of this species were taken at Cedar Keys, August 15.

Labia guttata Scudder.

This species is represented by a single female from San Pablo, taken August 13 from under pine bark.

BLATTIDÆ.

Isohnoptera johnsoni Rehn.

An adult female of this species was taken at Pablo Beach, August 11, from under palmetto root.

Eurycotis floridana (Walker).

Two females from Cedar Keys, August 15, represent this species.

Periplaneta americana (Linnæus).

This species was noticed at every locality visited in Florida.

Periplaneta australasiæ (Fabricius).

This species is represented by a nymph from Cedar Keys, August 15, taken under adherent dead petiole bases of palmetto. Mature individuals were seen at St. Augustine and Palatka.

Periplaneta truncata Krauss.

The evening of August 20 this species was found very abundant on the Clyde Line wharf at Jacksonville. Portions of the wharf under the electric lights seemed to be their favorite haunts, and when disturbed they scurried rapidly away or hid in the crevices between the planking. A series of seven males, eleven females and two nymphs are in the collection. Unquestionably this species is becoming more generally distributed in the Gulf States, and from the evidence in hand its strongholds are probably the larger ports, to which it has no doubt been brought by shipping from the tropics.

The series mentioned above exhibits considerable variation in the length of the tegmina and wings.

Pycnoscelus surinamensis (Linnæus).

A series of six females represent this species, the localities being Cedar Keys, August 15, Gainesville, August 17 (in room), Palatka, August 19, and St. Augustine, August 19.

The Cedar Keys specimens are all small and quite dark, with the pale cephalic line on the pronotum broadly interrupted in the middle and much reduced laterad. The individuals from the other localities have the tegmina paler, the cephalic pronotal margin distinctly and continuously marked and the general size greater.

MANTIDÆ.

Stagmomantis carolina (Johannson).

This species is represented by five nymphs from Pablo Beach, August 11 and 13 (in grass, palmetto scrub and pine woods), two nymphs from Gainesville, August 16 (undergrowth in pine woods), and one adult female specimen from Cedar Keys, August 15. The latter specimen, while fully adult, has the tegmina and wings but slightly exceeding the margin of the second abdominal segment.

Thesprotia graminis (Scudder).

One male from Gainesville, August 16 (undergrowth in pine woods), represents this species.

PHASMIDÆ.

MANOMERA[1] n. gen.

1900. *Bacunculus* Scudder, Proc. Davenport Acad. Nat. Sci., VIII, p. 95. [Not of Burmeister, 1838.]
1903. *Bacunculus* Caudell, Proc. U. S. Nat. Mus., XXVI, p. 872. [Not of Burmeister.]

On comparison of material of Scudder's *Bacunculus tenuescens* with specimens and figures of typical species of *Heteronemia* Gray (*Bacunculus* of authors, but not of Burmeister), it is evident that no close relationship exists in that direction, and affinity really exists with *Diapheromera* instead of *Bacunculus* of authors.

The original description given by Scudder omits mention of the very distinct spines present on the median femora of the male, although his figures (pl. 1, figs. 1 and 2) show their presence. On the basis of Scudder's description, Caudell, who had never seen the male sex, says, in describing the genus, "Legs of male unarmed." The spine of the median femora of the male is placed in the same position as in *Diapheromera,* and is very similar in character but slenderer, the caudal femora, however, being unarmed.

The structure of the abdominal appendages is fundamentally the same as in *Diapheromera* and not as in *Heteronemia,* the subgenital opercule being in no way like the latter genus. From *Diapheromera, Manomera* can be separated in the male by the slender head, the absence of caudal femoral spines, the uninflated median femora and the more elongate abdominal appendages.

Manomera tenuescens (Scudder).

A male from Pablo Beach, August 12, another from San Pablo, August 13, and three males and five females from Gainesville, August 16, represent this peculiar Florida form. The male from Pablo Beach was swept from marsh grass, but all the other individuals taken were from the wire-grass and other low undergrowth in pine woods, where protective resemblance would appear to be an important factor in the life of the insect.

The specimens vary considerably in size, particularly in the male sex, and represent two color phases, brown and green forms. These forms may be sexual as all the males are of the brown type and the females of the green, but it is hardly safe to assume this to be true on the amount of material in hand. The base color of the dorsum in the male varies from raw sienna to vandyke brown, the legs in all the specimens being greenish proximad, shading into olive or decided brownish distad. The lateral yellowish stripe is prominent in all the males, becoming whitish on the abdomen and extending to the base of the cerci. In the female this stripe is usually less prominent, and in one specimen is almost absent.

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[1] Μανος, *thin;* μηρα, *thighs.*

Aside from the above records this species has been recorded from Cedar Keys, Capron and Biscayne, Florida.

Anisomorpha buprestoides (Stoll).

Four males and three females from Pablo Beach, August 12 and 13, four males and six females from San Pablo, August 13, and one female from Gainesville, August 16, comprise the series of this species. Except for a Pablo Beach specimen taken in open palmetto scrub, all are from undergrowth in pine woods. A large part of the specimens were taken in coitu, and in one case two pairs and a single individual were taken from one plant.

From the material in hand it does not appear possible to separate two species, for while typical female specimens of what Caudell[2] calls *ferruginea* (Palisot) are in the series from San Pablo and a number of the others are true *buprestoides*, specimens from Gainesville and Pablo Beach connect the two extremes, the pale *ferruginea* and the strongly trilineate *buprestoides*. All the males collected are unquestionally true *buprestoides*. A pair from Osprey, Manatee County, Florida, in the Academy collection approach the pale type.

ACRIDIDÆ.

Nomotettix cristatus Scudder.

This species is represented by seven males and one female from Pablo Beach, August 12 and 13, one male and one female from San Pablo, August 13, and seven males, four females and two nymphs from Gainesville, August 16 and 17.

In the region examined this species appears to have little preference for one particular environment, as the Pablo Beach series contains specimens taken in undergrowth in open pine woods, on damp sand, in palmetto scrub and in grass. The San Pablo specimens were taken in pine woods undergrowth, and the Gainesville series in the same character of surroundings except one from the edge of a sink-hole.

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[2] *Proc. U. S. Nat. Mus.*, XXVI, pp. 880, 882.

Neotettix femoratus (Scudder).

One male and three females from Pablo Beach, August 12 and 13, taken in open pine woods undergrowth and palmetto scrub, represent this species. All the specimens are short-winged.

Neotettix bolteri Hancock.

An adult female and a nymph from Gainesville, August 16 and 17, belong to this rather scarce species. One was taken from a marshy sink-hole, the other in pine woods undergrowth.

Apotettix rugosus (Scudder).

A male individual from Cedar Keys, August 15, appears to represent this species. In the proportions of the pulvilli of the caudal tarsi it does not agree with the description given by Hancock,[3] and resembles in this respect the much smaller *Apotettix minutus* Rehn and Hebard. It is possible this specimen may not be true *rugosus*, but in all characters but the pulvilli proportions it is fully typical of that species.

Tettigidea spicata Morse.

A single male from San Pablo, August 13, was taken in undergrowth in pine woods. It belongs to the form with the elongate pronotum.

Tettigidea lateralis (Say).

This variable species is represented by a series of eight males and seven females from Pablo Beach, August 12 and 13, and one male from Gainesville, August 16. Individuals were taken in swampland, palmetto scrub, in undergrowth in pine woods and on damp sand. All the specimens are of the type with the produced pronotum, and considerable variation in the cephalic angle of the pronotum is observed.

Radinotatum brevipenne (Thomas).

This peculiar grasshopper was numerous in localities in pine woods undergrowth at Gainesville, August 16, two males, five females and one nymph being collected. At Pablo Beach, August 11 to 13, two males and five nymphs were taken in grass, palmetto scrub, pine woods undergrowth, and one of the males in marshland. Compared with spring experience around Thomasville, Ga., this species is not as common in the summer, but the number of adults is proportionately greater.

Mermiria alacris Scudder.

This strikingly colored species was numerous in pine woods undergrowth and palmetto scrub at Pablo Beach, August 11 and 13, six adult males, four females and three nymphs being collected. A single female from San Pablo, August 13, and three males from Gainesville,

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[3] *The Tettigidæ of N. Amer.*, p. 104.

August 16, were taken in pine woods. Cedar Keys is represented by a single male taken August 15.

Mermiria vigilans Scudder.

This species is more distinctly a marsh-loving form when compared with *M. alacris*, its favorite habitat being tall marsh grass in extensive tracts or narrow marsh drains. At Pablo Beach this species was common, particularly in a wet grassy drain along the railroad embankment, a series of fourteen males and twelve females being collected on August 11 and 12. At Cedar Keys, August 15, two males and two females were taken in salt marsh. In the series studied four females are in the green phase, while several males exhibit a similar tendency.

Mermiria intertexta Scudder.

A single male from Pablo Beach, August 13, represents this species, which can be separated from *vigilans* by the broader, distinctly triangular fastigium and the narrower disk of the pronotum.

Syrbula admirabilis (Uhler).

This species is partial to palmetto scrub and pine woods cover, being common but nowhere abundant at the localities visited. Pablo Beach is represented by seven males and four females taken August 11 to 13; Gainesville by three males, two females and one nymph; Cedar Keys, August 15, by one male.

All the specimens seen from Georgia and Florida are considerably larger than New Jersey individuals of the same sex.

Macneillia obscura Scudder.

In a restricted area in long-leaf pine woods at Gainesville, on August 16, this species was found in the undergrowth in moderate numbers, all the specimens seen being taken. A partiality on the part of the species for low oak growth was noticeable. The series in our hands from this locality consists of four adult males, six females and four nymphs. One of the males, two of the females and two nymphs have the median pronotal bar strongly marked, while one male and two females have it weaker but still quite apparent.

Amblytropidia occidentalis (Saussure).

Eight immature specimens from Pablo Beach, August 11–13, and four from Gainesville, August 16, appear to represent this species. Aside from individuals taken in dry palmetto scrub, these immature specimens were from pine woods undergrowth, in situations such as are favored by the adults in spring.

Orphulella pratorum Scudder.

The specimens from the localities given for this species have been compared with material from New Jersey, Maryland, Georgia, Florida and Alabama, all of which is considered by the authors to belong to this species. The Florida series here studied presents the usual color forms found in the species and was collected in a variety of habitats, ranging from dry pine woods undergrowth to open marsh. The localities represented are Pablo Beach, August 11–13, eight males, four females; Gainesville, August 16 and 17, six males, four females; Palatka, August 19, one female; Cedar Keys, August 15, two males. Nymphs were taken at Pablo Beach and Gainesville, and an adult male was taken during a train stop at Fairfax, S. C., August 10.

Orphulella pelidna (Burmeister). ?

The specimens here referred doubtfully to Burmeister's species have been carefully compared with the available determined material of this poorly understood species, and while they differ in a number of features from the other specimens, it can be positively asserted that they are not the allied *olivacea* or extremely large specimens of the species we consider to be Scudder's *pratorum*.

In size these specimens exceed any other North American individuals of the genus seen by us, particularly in the female sex. The fastigium is shaped much as in Nebraska specimens considered *pelidna*, but the tegmina and wings are very long, slender and not as broad as in *pratorum*. The largest male measures, length of body 20 mm; length of pronotum 4; length of tegmen 18.2; length of caudal femur 12.5; the largest female, length of body 27.5; length of pronotum 5; length of tegmen 23; length of caudal femur 17.

Aside from one male taken at Pablo Beach, August 12, the series of eleven males and twelve females were taken at Cedar Keys, August 15.

Dichromorpha viridis (Scudder).

This widely distributed species is represented by a series of twenty specimens, eight of which are in the brown phase. Jacksonville is represented by three males and six females, taken August 11, on a weedy lot in the middle of the city; Pablo Beach by three males, four females and two nymphs, taken August 11, 12 and 13, all in marsh except one male and a nymph from palmetto scrub and another nymph from grass; Gainesville is represented by two males and one female, August 16, in pine woods undergrowth and meadows.

Clinocephalus pulcher Rehn and Hebard.

This beautiful species is represented by an instructive series of forty-seven males and sixteen females, which show that it is quite closely related to *C. elegans*. A series of twenty-one New Jersey specimens of the latter species has been used for comparison and the differential characters are here treated separately.

Size.—This was the first character given in the diagnosis of *pulcher*, and the series in hand shows that *pulcher* is almost invariably larger than *elegans*, one male and one female alone being as small as the largest representatives of their respective sexes in the *elegans* series. The majority are as large, in general size, as the measurements of the types of *pulcher*.

Tegmina.—In none of the specimens examined are the tegmina quite as long as in the types of *pulcher*, and in the majority, particularly the east coast specimens, they are decidedly shorter, often no longer proportionately than in *elegans*.

Fastigium.—In the series of *pulcher* here studied the angle of the fastigium is less acute than in *elegans*. Some variation exists in the exact form of the angle, *i.e.*, the divergence of the margins; but as a whole, and in the vast majority of individuals, the fastigium is broader and less acute in both sexes.

Frontal costa.—In both sexes of *pulcher* the sulcation of the frontal costa is less pronounced and more rounded than in *elegans*, some of the Cedar Keys specimens having the sulcation very greatly reduced.

Color.—From a type similar to that found in *C. elegans* all the forms mentioned in the original description are contained in the series, in addition to which patterns there are several which suggest species of *Orphulella* in the way the dorsum is washed with rose purple.

To summarize, it appears that *Clinocephalus pulcher* is a southern representative of *C. elegans*, reaching its maximum of differentiation in southern Florida (Miami), where, as far as present material goes, it is a long-winged, or for the genus a long-winged, form. The specimens here referred are, on this account, not fully typical, but they are nearer to *pulcher* than to the small northern *elegans*. Gulf coast (Cedar Keys) specimens are as a rule nearer to typical *pulcher* than east coast (Pablo Beach and San Pablo) specimens, while interior specimens (Gainesville) are rather curious in that the males are similar to Cedar Keys males and the single available female is like east coast specimens.

That *elegans* and *pulcher* should be considered distinct appears to be the best way to handle the evidence the specimens give, the form of the fastigium and the depth of the sulcation of the frontal costa being "degree of difference" characters fully worthy of consideration, while the greater size of *pulcher*, and the complex coloration which it very frequently exhibits and which we have never seen in *elegans*, are to be given due consideration.

At Pablo Beach this species was abundant in a variety of localities, in dry palmetto scrub and undergrowth in pine woods, in rank grass growing in a wet drain along a railroad embankment and in open marshy spots. Twenty-four males, eleven females and two nymphs were taken at this locality, August 11 to 13. In pine woods at San Pablo two females were taken on August 13, and in a similar situation and at a wooded sink-hole two males and one female were taken August 16 and 17 at Gainesville. Cedar Keys is represented by twenty-one males, five females and two nymphs taken, August 15, in salt marsh and in palmetto scrub in open pine woods. Here the species was more abundant in salt marsh.

ŒDIPODINÆ.

Arphia xanthoptera (Burmeister).

A single female of this species from San Pablo, August 13, is in the collection. It was taken in pine woods undergrowth.

Arphia granulata Saussure.

Five males, three females and one nymph of this species were taken at Pablo Beach, August 11, 12 and 13, all captured in open palmetto scrub except one from grass.

There is a perceptible amount of variation in the arcuation of the crest of the pronotum, the majority having it distinctly but slightly arcuate, while the coloration of the caudal tibiæ is also variable, a pale disto-median annulus being present more or less distinctly in the majority of the specimens. With two exceptions the specimens have blackish brown predominating, the others being dull brownish.

Eucoptolophus costalis (Scudder).

This species enjoys a much wider distribution in the southeastern States than has usually been supposed to be the case. The present collection contains representatives from Jacksonville (one female, August 11, on city lot), Pablo Beach (three males, four females, August 11 and 12, palmetto scrub, grass and strand), Gainesville (one male, August 17, palmetto scrub) and Cedar Keys (one male, August 15).

In coloration a great amount of variation is present, the shades of brown ranging to seal brown. while the ochres are equally variable. One female from San Pablo has the whole head and pronotum, the better part of the caudal femora and patches on the distal portion of the tegmina green, while the Jacksonville individual has some green present on the tegmina, in the same position as on the above specimen.

An examination of available material shows this species to range along the Gulf coast from Texas to eastern Florida and south-central Georgia, the similarity of color phases and general appearance having caused in some instances its confusion with *Chortophaga viridifasciata.* Specimens from the following localities can be assigned to this species: Ocklockonee River and Thomasville, Thomas County, Ga.; Miami, Dade County, and Chokoloskee, Monroe County, Fla. Caudell has recorded it from Key West and Sanford, while the records of *Chortophaga viridifasciata* given by the authors[4] also belong to this species, as a re-examination of the material shows. Tampa is the only locality in the latter paper additional to those mentioned above.

Spharagemon bolli Scudder.

Two males and four females from Pablo Beach in open palmetto scrub, August 11 and 12, and a pair from Cedar Keys in palmetto scrub in pine woods, August 15, represent this species. The variations usually noticed in any series of this species, *i.e.*, shade of general color and strength of tegminal and femoral bars, are hardly as great as in northern specimens, and as a rule the specimens are more uniform than Maryland and New Jersey individuals.

Spharagemon collare wyomingianum (Thomas).

A single female from grassland at Gainesville, August 17, represents this race. The mottling of the head, pronotum, tegmina and femora is less striking than in New Jersey specimens of this form.

Scirtetica picta (Scudder).

A series of four males and two females from Pablo Beach, August 11, 12 and 13, and two males from Gainesville, August 17, represent this species. The Pablo Beach specimens were taken in a variety of habitats—strand, open palmetto scrub and along railroad tracks—while the Gainesville individuals are from palmetto scrub and grassland. One Pablo Beach specimen is quite uniform warm brown in color, the pale tegminal markings and the dark femoral bars alone but moderately indicated. The other extreme type, with great contrast between the bone white markings and blackish brown areas, is represented by one specimen from Pablo Beach, the remaining specimens presenting degrees of coloration intermediate between the two extremes. This species was noticed but not captured at Riverside, near Jacksonville.

Psinidia fenestralis (Serville).

This sand-loving species was taken at Jacksonville, one male, one female, August 11 and 20; Pablo Beach, three males, two females, one nymph, August 11 and 12, and Gainesville, one male and three females, August 16 and 17. At Jacksonville it was taken on a city lot and in a sandy field near the city; at Pablo Beach on the strand and in open palmetto scrub, and at Gainesville in palmetto scrub in pine woods and in grassland.

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[4] *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 38.

Trimerotropis citrina Scudder.

This widely ranging species is represented by material from Jacksonville and Pablo Beach. A single male from the former locality was taken August 11 on a city lot, and six males and four females from Pablo Beach were taken August 11, 12 and 13 on the strand, in palmetto scrub and along the railroad track. The strand was, however, the place of greatest abundance. A male taken at Swansea, Lexington County, S. C., August 10, in a sandy road is also referable to this species.

LOCUSTINÆ.

Dictyophorus guttatus (Stoll).

This curious grasshopper was numerous in tall weeds along the railroad track a short distance west of Pablo Beach, five males and two females being taken on August 13. The species was more abundant than the collected material would indicate as the remains of dozens of specimens were found along the track, the majority having been crushed by the wheels of the trains. The section where they were most numerous was bordered on the sides by woodland, and in the more open regions the species was not noticed. A female was captured on the hotel porch at Pablo Beach, August 12, and a single female was taken at Gainesville, August 16, in undergrowth in pine woods. Nymphs of this species were not noticed during the trip.

Stenacris chlorizans Walker.

At Pablo Beach, in open marshy spots scattered over the palmetto scrub, this species was numerous in grass of moderate height, and in a swampy area of tall grass north of the railroad track it was equally at home. In all situations its actions were similar to those noticed in the vicinity of Thomasville,[5] except that grass was used as a resting place instead of cat-tails, which did not occur except in the more pronounced portions of the wet areas. Nine males and five females were taken at this locality, August 11. Three males and two females were taken at Gainesville, August 17, in a marshy sink-hole in the pine woods.

Over half the specimens collected have the lateral pale bars either distinctly or slightly marked, while the dorsal aspect is strongly purplish in one male and slightly so in several others. But four specimens are of the full green coloration, *i.e.*, without lateral pale bars or traces of dorsal suffusion of purplish.

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[5] Vide *Proc. Acad. Nat. Sci. Phila.*, 1904, pp. 787, 788.

Leptysma marginicollis (Serville).

This species was found at Pablo Beach associated with the preceding. Two males, six females and four nymphs, representing two stages, were collected on August 11. The least developed of the nymphs was taken in palmetto scrub.

The lateral pale bars are strongly indicated in but four of the adult specimens.

Schistocerca americana (Drury).

Two females taken at Gainesville, August 16 and 17, in grassland and in undergrowth in pine woods, represent this species.

Schistocerca damnifica (Saussure).

Two males from Pablo Beach (August 11 and 12), one from San Pablo (August 13) and another from Gainesville represent this species. The Pablo Beach individuals were taken in open palmetto scrub and the others in undergrowth in pine woods.

An interesting fact concerning this species is that New Jersey specimens have the tegmina and wings distinctly shorter than Florida and Georgia specimens, the tegmina also with distal extremity broad and blunter, while the antennæ are usually longer and slenderer in the southern specimens. This species was noticed but not captured at Riverside, near Jacksonville.

Schistocerca alutacea (Harris).

The authors being of the opinion that *S. alutacea* (Harris) and *rubiginosa* (Scudder) represent color phases of the same species, the two types are here treated together. Fifteen males and ten females are included in the collection, of which three males and one female represent the *alutacea* type, the others being similar to northern "*rubiginosa*" individuals from the immediate coast, but with longer tegmina and wings than representatives from points in the interior of the pine barrens of New Jersey.

The entire series except one male is from Pablo Beach, taken August 11 and 12, all from open palmetto scrub except one female of the *alutacea* form taken in a swampy spot. Two males of the *alutacea* type—in fact the only males of this type taken at Pablo Beach—were collected in the open palmetto scrub in association with "*rubiginosa*" type. Gainesville is represented by one male of the *alutacea* type, taken August 17 in grassland.

The "*rubiginosa*" individuals from Pablo Beach are identical with individuals from the coast of southern New Jersey, *i.e.*, Cape May and Anglesea. The form found in the interior of the New Jersey pine region possesses short tegmina and wings and, as a rule, is of smaller size. If the recognition of *alutacea* and *rubiginosa* as distinct species is conceded, it would also be necessary to separate the pine land type from the coast dune type.

Schistocerca obscura (Fabricius).

This form, which is separated from *alutacea* by the narrower incision of the subgenital plate of the male and the color of the caudal limbs, is represented by three males and five females. Of these six were taken at Pablo Beach, August 11 and 12, in tall marsh grass and open palmetto scrub; one female at Gainesville, August 16, in undergrowth in pine woods, and another at Denmark, Bamberg County, S. C., August 10, in high weeds. The males here referred to this species have the subgenital plate with the lateral portions lapped over the incision, while the caudal tibiæ are decidedly blackish in all except in one female which has them blackish purple. The bars on the dorsal face of the caudal femora are indicated more or less distinctly in all the individuals, but in no case are they prominent. The general base color of all the females, and to a lesser extent of the males, is maroon, while the size appears to be greater in the female than in the average of *alutacea*. The coloration of the female of this species is very striking, but the males do not present so rich an appearance. The real value of this form as distinct from *S. alutacea* cannot be fully determined without the study of a large amount of material, as the single character of the narrower incision of the male subgenital plate alone can be relied upon, the greater length of the antennæ, size and coloration being variable in the allied species.

Two female specimens of this species from Maryland have also been examined, one from Chestertown (August 17, 1898; E. G. Vanatta), the other from Druid Hill Park, Baltimore (September, 1902; H. A. Wenzel). These specimens extend the range of the species considerably to the north of the former northern limit—North Carolina.

Gymnoscirtetes pusillus Scudder.

This peculiar species is represented in the collection by a most interesting series of 153 specimens taken as follows: Pablo Beach, August 11, 12 and 13, sixty-eight males, fifty-nine females, two nymphs; San Pablo, August 13, seven males, four females; Gainesville, August 17, four males and seven females; Cedar Keys, August 15, one female.

As a whole the series shows a considerable amount of variation in size in both sexes, but the extremes of the female are proportionately greater. The Gainesville series as a whole is slightly smaller than the average of Pablo Beach and San Pablo individuals. The smallest male and female measure 12.7 and 16.3 mm. in length of body; the largest 15.3 and 22 mm., all measured individuals being from Pablo Beach.

The structural variations noticed in Georgia specimens of this species[6] are also present in this series. The chief color variation in the dried specimens is the depth and extent of the purplish-brown dorsal color.

The habitats frequented by this species are open palmetto scrub, open marsh, tall marsh grass, undergrowth in pine woods and grassland, by far the greater number of specimens being taken in the palmetto scrub, and all situations are represented in the Pablo Beach series. One specimen from the latter locality was the prey of an asilid fly (*Diogmites,* probably *winthemi* Wied.) but little larger than the *Gymnoscirtetes* itself.

The localities at which this species has been taken, in addition to those given above, are Jacksonville (type locality) and De Funiak Springs, Fla., Waycross and Thomasville, Ga.

Eotettix signatus Scudder.

This beautiful species is represented by a series of ten males and four females taken at Pablo Beach, August 11, in marshy spots scattered over the palmetto scrub area back of the beach dunes. In size the specimens are quite uniform, and as the female sex has not been recorded the following measurements of it may be of some interest: Length of body 26.5 mm.; length of pronotum 6.2; length of tegmen 7.6; length of caudal femur 15.5. In color the little variation that is appreciable is probably due to discoloration in drying.

The only previous record of this species is the original reference, the typical material being one male from East Florida.

Eotettix palustris Morse.

At Gainesville, in the rank vegetation around a flooded sink-hole in pine woods, five males and five females of this species were taken on August 16 and 17. In the female sex this species appears to be more variable than *E. signatus,* but the coloration is, as far as available material goes, constant except for a tendency to suffuse the whole insect with pinkish-red. The extremes of the female sex measure 20.8 and 25 mm. in length of body; 5 and 5.2 in length of pronotum; 4 and 4.8 in length of tegmen, and 12.3 and 14.6 in length of caudal femur.

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[6] Vide *Proc. Acad. Nat. Sci. Phila.,* 1904, p. 789.

The only previous record of this species is from Live Oak, Suwanee County, Fla.

Hesperotettix floridensis Morse.

Two males and a female of this peculiar species were taken at Pablo Beach, August 12 and 13, and a second female at San Pablo, August 13. The Pablo Beach specimens were taken among grass in marshy spots in the palmetto scrub, and in tall grass growing in a wet drain along the railroad track. The San Pablo specimen was taken in undergrowth in pine woods.

The previous records of this species are from Hastings, St. John County, Fla., and Waycross, Ware County, Ga.

Melanoplus propinquus Scudder.

This austral representative of *M. femur-rubrum* is represented by a series of thirty-three specimens taken at four localities, at all of which the species was abundant in a variety of situations. The localities and dates are: Jacksonville, August 11, two males, one female; Pablo Beach, August 11–13, fourteen males, three females; Gainesville, August 16, four males, two females; Cedar Keys, August 15, three males, four females. At Jacksonville it was taken on a city lot, while the Pablo Beach series was collected in palmetto scrub, open grassy stretches and in tall marsh grass.

Size is a very variable character in this species and does not appear to be correlated with exact environment, one of the smallest and one of the largest males both being from tall marsh grass at Pablo Beach. Maximum and minimum measurements from Pablo Beach males are as follows:

Length of body, ...	22.2 mm.	17.6 mm.
Length of pronotum, ...	5.1 "	4 "
Length of tegmen, ...	20.2 "	15.8 "
Length of caudal femur, ...	13 "	10.7 "

Melanoplus inops Scudder.

A series of sixty-nine specimens represents this species, which was taken at all the points where any amount of collecting was done. The localities represented are: Pablo Beach, August 11–13, nine males, nine females; San Pablo, August 12, four males, three females; Gainesville, August 16 and 17, twenty males, fourteen females; Cedar Keys, August 15, two males, seven females, one nymph. At Pablo Beach the species was numerous in the open palmetto barrens; at San Pablo, Gainesville and Cedar Keys it frequented the undergrowth in pine woods, sometimes, particularly at Cedar Keys, among saw palmetto.

The cerci of the males exhibit an appreciable amount of variation, and types with these appendages more curved or straighter than figured by Scudder[7] can be found in the series before us. In some individuals the cerci are more robust, in others slenderer; in some the extreme apex is slightly narrowed, in others obliquely truncate. The furcula are distinct in the majority of the specimens; in some present as considerably depressed trigonal lobes. Specimens with the furcula obsolete as described in the type are in the minority.

In size the specimens from the Atlantic side of the peninsula average larger than those from the Gulf coast and the interior pine land (Gainesville), the San Pablo males also averaging as large as the largest Pablo Beach representative of the same sex. As maximum and minimum measurements may be of interest the extremes of each sex are here given:

	Cedar Keys, Aug. 15. ♂	San Pablo, Aug. 13. ♂	Cedar Keys, Aug. 15. ♀	Pablo Beach, Aug. 11. ♀
Length of body, . .	14.6 mm.	17.5 mm.	17 mm.	21.6 mm.
Length of pronotum, .	3.5 "	4.5 "	4.1 "	5 "
Length of tegmen, . .	2.7 "	4 "	3.3 "	4.4 "
Length of caudal femur,	9 "	10.8 "	11 "	13 "

In coloration a considerable amount of variation is present in the tone of the general color and the presence or absence of femoral bars. The dark dorsal sections of the lateral lobes of the pronotum vary considerably in depth, being very prominent and solid in some specimens and almost absent in others, which also holds true regarding the two dark bars on the dorsal aspect of the caudal femora. These latter are quite broad, strongly contrasted and obliquely disposed in a few specimens, indicated in a less pronounced manner in the majority of specimens and almost absent in others. These variations as well as those in the tone of the general color are irrespective of locality or sex. The general tone varies from a grayish tendency through umbers to a burnt sienna type.

This species was described from a single male labelled "Florida," and up to this writing nothing additional has been published regarding it. A female from Lemon City, Dade County, Fla., has also been examined, the tegmina of which are somewhat smaller than those of individuals from northern Florida.

Melanoplus keeleri (Thomas).

Thirteen specimens are referred to this trim species distributed as follows: Pablo Beach, August 11, 12 and 13, five males, one female;

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[7] *Proc. U. S. Nat. Mus.*, XX, pl. XXII, fig. 4.

San Pablo, August 13, two males, three females, one nymph; Gainesville, August 16, one male. At Pablo Beach the species was found in palmetto scrub, in tall marsh grass and along a sparsely covered railroad embankment, while at San Pablo and Gainesville it was found in the undergrowth in pine woods.

In color the series exhibits a moderate amount of variation, chiefly in the shade of the base color, although the dark maculations also vary somewhat in extent and intensity in proportion to the depth of the base color, being weaker in the individuals with an ochraceous base and well marked in those with a brown general tint. The caudal tibiæ are scarlet vermilion in all the adults and glaucous in the single nymph.

The form of the male cerci is as variable in the present series as in the one from south Florida previously studied by the authors,[8] and the extremes in the series of eight males are well marked and a number of intermediates are also present, the latter constituting the greater part of the lot. The *keeleri* extreme with the slender elongate accessory lobe is on the other hand replaced by one with the accessory lobe almost absent, represented in fact by an angulation, while the other specimens when arranged according to their cercal character form a complete transition from one to the other.

On examining the original references of *keeleri* and *deletor* it is evident that the claim made by Scudder[9] that *keeleri* is smaller than *deletor* is refuted by the measurements originally given from typical material. Thomas gives the measurements of *keeleri*, a female, as follows: Length of body 1.12 inches (28.4 mm.), length of tegmen .88 (22.3 mm.), length of caudal femur .70 (17.7 mm.); while Scudder gives the following for *deletor:* Length of body, male 23.5 mm., female 30.5; length of tegmen, male 21, female 22; length of caudal femur, male 14.5, female 16. It would appear from the records and evidence of material that this species is small toward the northern limit of its range (at least on the Atlantic coast) in North Carolina, from which region it ranges along the coastal plain and Gulf region to Texas and up the Mississippi to Missouri, reaching in southern Florida its maximum of size. The type of *keeleri* was from Florida and those of *deletor* from Texas, the measurements of the original specimens of both species differing little, being very much the same as found in the material studied in this connection. On the other hand south Florida (Miami) specimens are uniformly larger,[10] an average pair measuring as follows:

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[8] *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 40.

[9] *Proc. U. S. Nat. Mus.*, XX, p. 344.

[10] This is also true of *Melanoplus puer* (vide *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 40), Miami individuals of which are very considerably larger than north and central Florida representatives.

	♂	♀
Length of body,	25 mm.	31 mm.
Length of pronotum,	6 "	7.2 "
Length of tegmen,	27 "	25.5 "
Length of caudal femur,	15.2 "	18.2 "

As I imagine Scudder's measurements, in his Revision of the Melanopli, were taken from the specimen of *keeleri* there figured, their small size is due to the fact the individual was from North Carolina.

On the evidence of the material examined I am compelled to consider *Melanoplus deletor* Scudder a synonym of *Melanoplus keeleri* (Thomas).

Paroxya atlantica Scudder.

A series of forty-five specimens represent this species, the several localities being as follows: Pablo Beach, August 11, 12 and 13, twenty-seven males, seven females; Gainesville, August 16 and 17, six males, two females; Cedar Keys, August 15, one male, two females. At Pablo Beach the species was numerous among the tall grasses growing in extensive wet areas, drains and in the smaller marshy spots in the palmetto scrub, while at Gainesville the vicinity of a sink-hole in the pine woods was frequented. Salt marsh was the environment in which it was found at Cedar Keys.

There is an appreciable variation in size in the Pablo Beach series, particularly in the males. In color there is considerable variation in the degree of purity of the yellow color. The two Gainesville females are deeper in color than the average Pablo Beach individuals, while both Cedar Keys females and one of two from Gainesville have the dorsum of the head, pronotum, caudal femora, face, limbs and ventral portion of the lateral lobes of the pronotum washed with wine purple.

Paroxya floridiana (Thomas).

At Pablo Beach this species was found frequenting tall grass growing along a railroad drain, four males and two females being taken on August 11. At Gainesville a single female was taken near a sink-hole in undergrowth in pine woods on August 16.

When compared with material from the northern portion of the range of the species the Florida specimens are seen to be much larger, and a comparison of material shows a steady increase in size as one proceeds southward. In view of this fact comparative measurements of specimens from several points within the range of the species are here given. No effort has been made in the selection of specimens for measurement to pick only those supporting the view expressed above, as on the contrary the individuals used have been taken haphazard when more than a single pair was available from the locality which it was desired to represent.

Males.

	Arner, Ontario.	Bear Swamp, Burl. Co., N. J.	Roslyn, Va.	Pablo Beach, Fla.
Length of body, . .	20.6 mm.	22 mm.	24.2 mm.	32.5 mm.
Length of antenna, .	13 “	13.1 “	16.5 “	19.5 “
Length of pronotum, .	4.3 “	4.5 “	5.2 “	6.8 “
Length of tegmen, . .	11.2 “	16 “	16.4 “	22 “
Length of caudal femur,	12 “	12 “	14 “	17.5 “

Females.

	Arner, Ontario.	Clementon, N. J.	Roslyn, Va.	Pablo Beach, Fla.
Length of body, . .	32 mm.	33.2 mm.	36.1 mm.	44 mm.
Length of pronotum, .	6.5 “	7 “	7.1 “	8.8 “
Length of tegmen, .	18.6 “	17.5 “	18.2 “	28.2 “
Length of caudal femur,	15.8 “	17 “	18.2 “	22.6 “

Aptenopedes sphenarioides Scudder.

This interesting species is represented in the material collected by a series of eighty-six individuals. The localities represented are Pablo Beach and Gainesville, the former by twenty-nine adult males, eleven adult females, six male nymphs and eighteen female nymphs; the latter by five adult males, one adult female, eleven male nymphs and five female nymphs. At Pablo Beach it was taken August 11, 12 and 13, in dry palmetto scrub, undergrowth in open pine woods, in grassland and in tall marsh grass. At Gainesville, on August 16 and 17, it was found chiefly in undergrowth in pine woods, the vicinity of a sink-hole being inhabited by it.

The nymphs represent two stages and show that the principal color characters of the adults are indicated for a considerable time before the individual is mature.

The size of the adult specimens is quite uniform in the Pablo Beach series, but the Gainesville males show a very appreciable amount of variation, the extremes measuring 18 and 20.8 mm. in length of body.

Aptenopedes aptera Scudder.

A series of eighty-six specimens represent this interesting species. Pablo Beach is represented by thirty-eight adult males, nineteen adult females, four male nymphs and nine female nymphs taken August 11, 12 and 13. At this locality the species was found associated with *A. sphenarioides* particularly in the palmetto scrub, and but slightly less abundant than the latter species. At San Pablo, August 13, two males and three females were taken in the undergrowth in the pine woods. One adult male and five female nymphs were taken at Gainesville, August 16 and 17, in pine woods undergrowth, chiefly scrub palmetto. Cedar Keys is represented by two adult males, one male nymph and two female nymphs, taken August 15 in pine woods undergrowth.

Two stages are represented in the nymphs from Pablo Beach, only one from the other localities. This species does not possess two color phases differing markedly as in *A. sphenarioides*, most of the variation observed being in the intensity of the median abdominal bars and the lateral bars of the pronotum. The nymphs in several instances have the abdominal bars strongly marked and almost wholly washed with purplish pink. The Pablo Beach series of adults is quite uniform in size, several females alone being conspicuous on account of their smaller size. The single Gainesville male, however, is distinctly larger than individuals of the same sex from any other locality, the length of body being 21.3 mm., while the largest Pablo Beach male measures 18.5.

This species has been recorded previously in Florida from Fort Reed, Orange County, Jacksonville, Duval County, and Miami, Dade County. A male from Gotha, Orange County, has also been examined.

TETTIGONIDÆ.

Arethæa phalangium (Scudder).

A single female of this interesting species was taken in the undergrowth in pine woods at Gainesville, August 16. This specimen was the only representative of the species noticed and constitutes the first record of the same from Florida. The previous records are Georgia (Scudder, Brunner), Thomasville, Ga. (Rehn and Hebard), and Victoria, Texas (Caudell).

Scudderia texensis Saussure and Pictet.

This widely ranging species was taken at Pablo Beach and Gainesville, two males being taken August 13 at the former locality and one of the same sex on August 16 at the latter.

The environment at the first locality was open grassland and the slope of a railroad embankment and undergrowth in pine woods at the second.

Scudderia laticauda Brunner.

At San Pablo a single female of this large form was taken August 13 in pine woods undergrowth. A series of three males and four females taken August 16 at Gainesville in a similar environment are also referred to this species. The Gainesville males show close relationship in the form of the genitalia to the figure of *S. curvicauda* given by Scudder, but the females are unquestionably *laticauda* by the size and shape of the ovipositor. The males are larger than northern specimens of *curvicauda*, agreeing in this respect with the associated Gainesville females and also with the measurements given by the describer.

Scudderia cuneata Morse.

A single female from Pablo Beach, August 11, in palmetto scrub, represents this species. A female from Miami has been used for comparison and the Pablo Beach individual differs only in its slightly smaller size.

The range of this species is now known to be from Alabama and southern Georgia (Thomasville) south to southern Florida (Miami).

Symmetropleura modesta Brunner.

This species, previously known only from the male type from "Carolina" and a female specimen from North Carolina, is represented by a male individual taken from floating water hyacinth (*Piaropus crassipes*) in the St. John's River by the wharves of Palatka, on August 18. No other specimen of the species was noticed.

When compared with Brunner's original description the Palatka male is slightly larger than the type, and also differs in having the margins of the tympanum and the caudal margin of the tegmina lined with ochraceous, in addition to the angles of the pronotum mentioned in the original description. The apices of the tegmina are slightly and the exposed portions of the wings are strongly washed with brownish.

Amblycorypha floridana Rehn and Hebard.

A series of two males and six females represents this species, the original basis of which was chiefly damaged material. With the material in this series more detailed comparisons can be made with *A. oblongifolia*, to which *floridana* is closely allied.

The less curved form and rather smaller size of the ovipositor will serve to separate the female of *floridana* from that of *oblongifolia*, while in the male the tympanum is distinctly narrower, both actually and proportionally, than in *oblongifolia*. The lateral angles of the disk of the pronotum are as a rule by no means as sharply rectangulate as in *oblongifolia* and the disk itself is broader caudad in the latter species. From the evidence in hand it appears that *floridana* represents the southern extreme of *oblongifolia*, as individuals from Thomasville, Ga., are as near *floridana* as *oblongifolia*, the ovipositor being more curved and larger and the pronotal angles more distinct than in *floridana*, but the narrower tympanum and the comparatively narrower caudal section of the pronotal disk show relationship to the same species.[11] In no one of the characters, however, is an extreme represented, but an intermediate position is clearly recognizable. Thus from the evidence in hand true *floridana* is apparently restricted to Florida, grading north over an undetermined area into true *oblongifolia*, the type locality of which is Pennsylvania.

The series in this collection was taken at Pablo Beach, August 11 and 13, two males, two females; San Pablo, August 13, one male, and Gainesville, August 16, three females. At Pablo Beach individuals were taken in salt marsh, swampland and in tall bushes on the dunes, and at San Pablo and Gainesville in undergrowth in pine woods.

The San Pablo individual is in the pinkish phase of coloration. Other individuals of *A. oblongifolia* in this type of coloration in the Academy collection are from Absecon, N. J., and Wood's Hole, Mass.

Amblycorypha uhleri Stål.

A single male of this species was taken at Gainesville, August 16, in undergrowth in pine woods.

This is the first Florida record of the species.

Cyrtophyllus (Lea) floridensis Beutenmüller.

This interesting katydid was found to be abundant in certain bushes about eight to ten feet high growing on the land face of the dunes at Pablo Beach. On August 12 six males and on August 13 nine males were captured. They were taken wholly with the aid of their song which began shortly before evening. The song, as was stated by Beutenmüller, is distinctly different from that of *C. perspicillatus*, being much lower, decidedly weaker and consisting of single notes separated by regular intervals.

The generic name *Lea* proposed by Caudell[12] is not applied by us, as the characters assigned to the genus do not appear to the authors to be of sufficient weight to have generic value, although *floridensis* is to our mind worthy of being considered subgenerically distinct from *C. perspicillatus*.

The color of the living individuals was essentially as in the dried specimens, which were stuffed in the field and have lost but little in consequence. The general dorsal color is bice green, becoming pale green on the limbs and olive-buff on the head and pronotum, the eyes cinnamon and the lateral margins of the disk of the pronotum and the tympanal fields of the tegmina raw umber. The thickened anal vein of the male tegmina and the sutural margins of the same are yellowish or light greenish.

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[11] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 795.

[12] Vide *Journ. N. Y. Ent. Soc.*, XIV, pp. 34 and 42.

In size the species exhibits a considerable amount of individual variation, and the measurements of the extremes of the series of males and also of a female specimen are here given:

	♂	♂	♀
Length of body, ...	30 mm.	40 mm.	38.5 mm.
Length of pronotum, ...	6.4 "	7.5 "	7.5 "
Width of caudal margin of the pronotum	6.3 "	7 "	6.8 "
Length of tegmen, ...	32 "	35 "	34.2 "
Length of caudal femur, . . .	23.1 "	24.2 "	26 "
Length of ovipositor, ...			18.2 "

In addition to the fifteen Pablo Beach males a single female, of which the measurements are given above, from St. Augustine (C. W. Johnson) has been examined. The range of the species is now known to extend in a narrow strip along the coast from Pablo Beach, Duval County, to the vicinity of Grant, Brevard County, Fla.

Belocephalus subapterus Scudder.

A series of eleven specimens, one adult male, three adult females and seven immature individuals, represent this species. At Pablo Beach it was found on August 11, 12 and 13, in palmetto scrub and in low growth along the railroad track, three of the adults being taken at that locality. At San Pablo, August 13, one immature individual was taken in pine woods undergrowth. The remaining specimens were taken at Gainesville, August 16, in pine woods undergrowth. All the adults taken were in the green phase of coloration. The range of this species now extends from Thomasville, Ga., to Miami and Chokoloskee, southern Florida, specimens having also been recorded from Fort Reed, Orange County, Fla., in addition to the localities given above.

Conocephalus retusus Scudder.

At St. Augustine a series of four males and two females of this species were taken from the hedges of a garden on the evening of August 19.

When compared with the northern *Conocephalus atlanticus* Bruner, this species is seen to differ only in the somewhat greater general size and in the longer caudal limbs. Probably *atlanticus* will prove to be merely a smaller northern form of *retusus*, as a specimen from Roslyn, Alexandria County, Va. (October 22, 1900; J. A. G. Rehn), occupies an intermediate position. Typical females of the two forms and the Roslyn specimen measure as follows:

	Phila. Neck, Pa.	Roslyn, Va.	St. Augustine, Fla.
Length of body,	26 mm.	25.2 mm.	28.5 mm.
Length of pronotum,	6.5 "	6.2 "	7.5 "
Length of tegmen,	28.8 "	30.5 "	34.5 "
Length of caudal femur,	20.2 "	22.5 "	26.5 "
Length of ovipositor,	31 "	36.2 "	35 "

Conocephalus mexicanus Saussure.

A single female of this species was taken at Cedar Keys, August 15. The caudal femora are slightly longer than in a Tampa specimen, but otherwise the two are inseparable.

Conocephalus crepitans Scudder.

A single female of this species was taken at Warchard, Levy County, August 14, during a brief stop of the train. It was in undergrowth in the pine woods close to the railroad track.

When compared with a female of the species from Lincoln, Neb., the Florida specimen differs only in the slightly longer legs and ovipositor, being identical in all other characters. The measurements of the two specimens are as follows:

	Lincoln, Neb.	Warchard, Fla.
Length of body,	36.5 mm.	36 mm.
Length of pronotum,	8.5 "	8.8 "
Length of tegmen,	55 "	59.5 "
Length of caudal femur,	28.8 "	34.8 "
Length of ovipositor,	32.8 "	36.2 "

The capture of this species in Florida carries its range a considerable distance east, the previously known range extending from Nebraska and Iowa south to Texas and Arkansas.

Conocephalus melanorhinus n. sp.

Type: ♀; Cedar Keys, Levy County, Fla., August 12, 1905. (Hebard and Rehn.)

Allied to *C. robustus* Scudder and *lyristes* Rehn and Hebard, differing from the former in the blunter fastigium which is almost wholly black ventrad, the narrower disk of the pronotum, the straighter tegmina and the slightly deeper and considerably shorter ovipositor. From *lyristes* the new species differs in the larger size, the form of the fastigium, the more robust general form and the shorter ovipositor.

Size rather large; form elongate, rather slender. Head with the fastigium hardly elevated dorsad of the level of the occiput; fastigium distinctly longer[13] than the greatest width, apex blunt, subtruncate, ventral tooth separated from the frontal fastigium; angle of the face very considerable; eyes little prominent, slightly flattened; antennæ rather short, the length slightly exceeding that of the caudal femora. Pronotum rugoso-punctate, the dorsum deplanate, the lateral angles distinct caudad but not sharp; cephalic margin of the disk with a very slight median emargination, caudal margin of the disk moderately arcuate, lateral margins of the disk slightly diverging caudad; lateral lobes of the pronotum distinctly longer than deep, cephalic margin considerably oblique, caudal margin with a deep rectangulate sinus ventrad of which the margin is strongly rounded, ventral margin obtuse-angulate. Tegmina elongate, exceeding the tips of the caudal femora by about the length of the head and pronotum together, narrow, apex narrowly rounded. Abdomen with the terminal dorsal abdominal segment produced into a pair of spinose processes between which the segment is deeply cleft; supra-anal plate trigonal, produced mesad into a rather long finger-like process; styles rather short, thick, acute, slightly arcuate; ovipositor slightly shorter than the caudal femora, straight, rather broad and subequal, apex acute; subgenital plate moderately produced, apical margin emarginato-truncate. Cephalic limbs of medium build. Caudal femora rather slender, the proximal half moderately inflated, externo-ventral margin with two to four spines, interno-ventral margin with six to seven spines; caudal tibiæ more strongly spined on the dorsal than on the ventral margins; caudal tarsi quite elongate and slender.

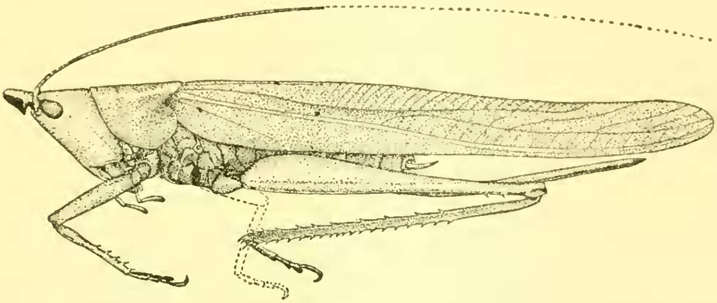

Fig. 1.—*Conocephalus melanorhinus* n. sp. Lateral view of type. (× 1½.)

General color apple green approaching oil green in areas on the dorsum of the fastigium and margins of the pronotum, lateral as well as dorsal. Fastigium marked laterad with maize yellow, ventral aspect of the fastigium black, oil green caudad; eyes ochraceous-buff;

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[13] Measurement taken from the interantennal space.

antennæ burnt carmine, pale and weak proximad. Pronotum with the lateral angles marked with maize yellow. Caudal tibiæ vinaceous pale on the angles; tarsi of all the limbs with the lateral portions dull purplish brown, the median area buff. Ovipositor ochraceous as is also the abdomen, distal two-thirds oil green, touched with brown at the apex, the median suture lined with black for the greater portion of its length.

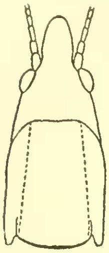

Fig. 2.—*Conocephalus melanorhinus* n.sp. Dorsal view of head and pronotum. (× 2.)

Measurements.

Length of body (exclusive of ovipositor),	35	mm.
Length of pronotum,	8	"
Greatest caudal width of disk of pronotum,	4.5	"
Length of tegmen,	48	"
Length of caudal femur,	27	"
Length of ovipositor,	22.8	"

The type of this species is the only specimen seen.

Orchelimum glaberrimum (Burmeister).

This species is represented by seven male individuals taken at five localities: Jacksonville, August 10 and 11, two taken from high bushes in city park; Pablo Beach, August 12, two from wet grassy spots in scrub palmetto barrens; San Pablo, August 13, one from undergrowth in pine woods; Gainesville, August 17, one from grassy margin of sinkhole; Cedar Keys, August 15, one from salt marsh.

In size some variation is noticed, chiefly in the length of the tegmina and wings and in the length of the caudal femora. The tegmen and wing variation is quite considerable, the extremes for the length of the exposed combined tegmina and wings being 27 and 34.5 mm.

Orchelimum nitidum Redtenbacher.[14]

Two males of this species were taken at Jacksonville, August 11, and Palatka, August 19. In both cases the specimens were taken in the city.

The absolute identification of Redtenbacher's species is attended with considerable difficulty, as the species here described as *O. molossum* is in many respects very closely allied. The present authors previously confused these two forms and recorded both as *O. nitidum*.[15] However, the form of the male cerci is the one character which will enable the student to recognize the two types with certainty and celerity. Redtenbacher's description says, "Cerci male subacuminati, vix compressi," and this clearly applies to the form for which his name is here used, *O. molossum* having the cerci depressed and not even slightly compressed. The cercus of *O. nitidum* is very slightly compressed in the distal half with a slight dorsal keel, and a figure is here given to fix the species with certainty. Cercal and ovipositor peculiarities are unquestionably among the chief characters to be used in separating the species of *Orchelimum*.

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[14] Attempts to determine material by the presence or absence of spines on the ventral surface of the caudal femora having proved futile, we are compelled to abandon this character, which in our opinion is generally too individual in its variations to be diagnostic in this genus. The forms here treated have been recognized chiefly by characters of the genitalia of both sexes, which are more stable and of sufficient diversity to separate the species with the least difficulty.

[15] *Proc. Acad. Nat. Sci. Phila.*, 1904, p. 796. (Thomasville, Ga.)

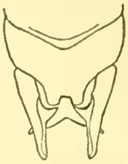
Fig. 3.–*Orchelimum nitidum* Redtenbacher. Dorsal view of apex of male abdomen. (× 4.)

Measurements of the specimen, of which a cercus is figured, are as follows:

Length of body,	22.5 mm.
Length of pronotum,	5.8 "
Length of tegmen,	23.5 "
Length of caudal femur,	20.2 "

The range of this species now includes Georgia and Florida.

Orchelimum molossum n. sp.

Types: ♂; Pablo Beach, Duval County, Fla., August 13, 1905. ♀; Gainesville, Alachua Co., Fla., August 16, 1905. (Hebard and Rehn.)

Closely allied to *O. nitidum*, but differing in the slightly heavier fastigium, the smaller pronotum with narrower lateral lobes, the smaller and more delicate tympanum of the male tegmina, the smaller, slightly depressed cerci, which have the tooth about median, and the slightly deeper emargination of the subgenital plate of the male.

Size moderately large (for the genus); form rather slender. Head rather broad; fastigium moderately broad, slightly elevated and rounded dorso-ventrad, apex more rounded transversely in the male than in the female, a fine median longitudinal depression present on the apex in both sexes, ventral portion narrowed and in contact with the fastigium of the face; eyes rather large, moderately prominent; antennæ extremely long. Pronotum with the dorsum flattened, caudal transverse sulcus impressed; cephalic margin of the disk subtruncate, caudal margin arcuate, lateral angles distinct only on the caudal lobe and there well rounded; lateral

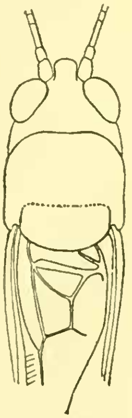
Fig. 4.–*Orchelimum molossum* n. sp. Dorsal view of head, pronotum and tympanum of male type. (× 3.)

lobe about as deep as long, the ventral margin subrectangulate, elytral sinus shallow and broad, the margin evenly arcuate ventrad of the same, convex callosity well defined in both sexes. Tegmina elongate, slightly tapering, apex rounded; tympanum rather light, slightly longer than wide. Wings projecting beyond the tegmina by less than the length of the head, apex narrowly rectangulate. Terminal dorsal abdominal segment of the male with two median rounded lobes separated by a deep rounded emargination; cerci straight except for a mesad bend at the middle, the proximal half robust, the distal portion tapering, acute, tooth on the internal face on the same plane as the cercus, stout, slightly recurved, acute; subgenital plate of the male ample, scoop-like, reaching about to the teeth of the cerci, distal margin rectangulate-emarginate, provided laterad with distinct but rather short styles. Supra-anal plate of the female acute-trigonal; ovipositor rather short, falciform, in length slightly shorter than the head and pronotum together, equal in width in the proximal half, tapering in the distal half, apex acute, the margins of the apex with slight traces of serrations; subgenital plate short, bullate, the extreme apex very slightly rectangulate-emarginate. Cephalic and median limbs moderately robust. Caudal femora about equal to three-fourths (♂) or four-fifths (♀) of the tegminal length, strongly bullate in the proximal half, externo-ventral margin armed with from two to five spines.

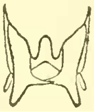

Fig. 5.—*Orchelimum molossum* n. sp. Dorsal view of male appendages. (× 5).

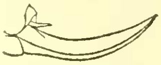

Fig. 6.—*Orchelimum molossum* n. sp. Lateral view of ovipositor. (× 2.)

General color pale apple green, washed on the dorsum with tawny ochraceous, a weak sub-lyrate pattern on the pronotal disk of the latter color, while the principal vein of the tympanum is also marked with it. Eyes of the male raw umber, of the female clove brown. Ovipositor greenish brown, male appendages ochraceous.

Measurements.

	♂	♀
Length of body,	21.5 mm.	21.8 mm.
Length of pronotum,	5 "	5.6 "
Length of tegmen,	24.5 "	25 "
Length of caudal femur,	17.6 "	20.8 "
Length of ovipositor,[16]		8 "

[16] Ventral length.

While this species is closely related to *O. nitidum*, it is not possible to refer the specimens here placed under the new form to the older species, and at the same time take proper cognizance of differences in the genitalia. As far as our available material goes the two forms are perfectly distinct, and for this reason it appears best to regard them for the present at least as separate species.

Three males and one female from Florida have been examined in addition to the types. One male is paratypic with the type of that sex, and the remaining individuals are paratypic with the female (August 16 and 17). At Pablo Beach the species was found in grass along railroad tracks, and at Gainesville it was taken in fields in the undergrowth of pine woods around a sink-hole. The species also ranges into southern Georgia at Thomasville (*vide supra*).

Such variation as exists in size in the specimens examined is comparatively slight, and in color the chief variation is in the intensity of the paired brown bars on the pronotum. The latter feature varies from a form with a pair of distinct slightly constricted, sublyrate bars to one in which they are only faintly suggested. In but one case, however, do they extend upon the metazona.

Experience in the field demonstrated the bulldog-like tenacity with which this species retains its grip when on the defensive, and the specific name has been given for this reason. In one case its hold was so strong that the head was torn from the body without the jaws relaxing their grip.

Orchelimum fidicinium n. sp.

Types: ♂ and ♀; Cedar Keys, Levy County, Fla., August 15, 1905. (Hebard and Rehn.)

Allied to *O. delicatum* and *gladiator* Bruner from Nebraska and Indiana, but differing from the former in the longer cerci of the male, the shorter subgenital plate of the same sex, and the slightly shorter and slenderer ovipositor. From *gladiator* it differs in the much slenderer ovipositor, longer limbs, shorter subgenital plate of the male and the heavier and longer male cerci.

Size small (for the genus); form elongate. Head with the fastigium not appreciably elevated above the level of the occiput; fastigium rather long, narrow, subequal, the apex rotundato-truncate when viewed dorsad, moderately rounded when viewed laterad, fastigium of the face in contact with that of the vertex; eyes rather large, somewhat prominent when viewed dorsad; antennæ about three times the length of the body. Pronotum with the disk but little flattened; cephalic margin slightly emarginato-truncate, caudal margin moderately arcuate, no lateral shoulders present on the prozona, present but rounded on the metazona, transverse sulci moderately distinct; lateral lobes very slightly longer than deep, the humeral sinus shallow and broad, ventral margin obtuse-angulate, convex callosity moderately distinct. Tegmina slightly longer than the body, their apices reaching to the genicular extremity of the caudal femora, narrow, apex narrowly rounded; tympanum of the male rather small and weak. Wings exceeding the closed tegmina by about the length of the head. Terminal dorsal abdominal segment of the male very narrowly divided mesad; cerci nearly straight, robust in the distal half, apical half tapering, immediate apex blunt, tooth placed interno-ventrad, rather long but not stout, recurved, acute; subgenital plate hardly surpassing the base of the cercal tooth, moderately inflated, subcarinate caudo-laterad, caudal margin obtuse-angulate, styles very short. Supra-anal plate of

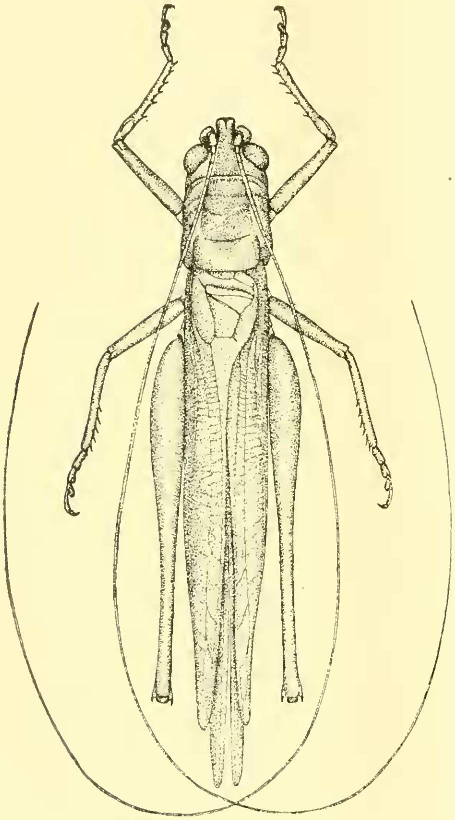

Fig. 7.—*Orchelimum fidicinium* n. sp. Dorsal view of male type. (×3.)

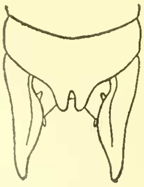

Fig. 8.—*Orchelimum fidicinium* n. sp. Dorsal view of apex of male abdomen. (× 6.)

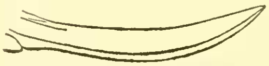

Fig. 9.—*Orchelimum fidicinium* n. sp. Lateral view of ovipositor. (× 3.)

the female lanceolate; styles slightly arcuate, tapering; ovipositor slightly less than twice as long as the head and pronotum together, slightly falcate, moderately broad and subequal in the proximal half, tapering distad to the acute apex; subgenital plate of the female trigonal, somewhat inflated, the narrow apical portion subtruncate. Caudal femora considerably inflated proximad, ventral margins unarmed.

General color varying from buff to tawny olive, distinctly greenish in life, the lateral aspects of the head, pronotum and pleura pale olive-buff in the dried specimen. Eyes broccoli brown; antennæ burnt umber becoming drab distad; a broad median bar from the fastigium to the caudal section of the pronotal disk burnt umber, broken and irregular in the female; caudal tibiæ with the dorsal face olive.

Measurements.

	♂	♀
Length of body,	18.5 mm.	16 mm.
Length of pronotum,	3.8 "	4 "
Length of tegmen,	20 "	21 "
Length of caudal femur,	16 "	16.8 "
Length of ovipositor,		10 "

A paratypic series of ten males and nine females have also been examined, as well as a single male taken at Gainesville (August 16; in pine woods). The series exhibits some slight variation in size and considerable in the intensity of the broad median bar on the head and pronotum. In several specimens the latter is hardly indicated. The amount of variation in the shape of the ovipositor is very slight, and practically no variation is noticed in the form of the male cerci.

This species was found in the flooded salt marsh among tall grasses. The individuals displayed great agility in eluding capture, using both their leaping and flying power, those taken being secured chiefly by beating.

Orchelimum militare n. sp.

Types: ♂ and ♀; Gainesville, Alachua County, Fla., August 17, 1905. (Hebard and Rehn.)

Allied to *O. delicatum* Bruner and *O. volantum* McNeill, differing from both in the very long ovipositor and peculiar cerci. From *delicatum* it also differs in the larger size and the shorter subgenital plate of the male.

Size medium (for the genus), form moderately slender. Head with the fastigium very slightly elevated, the fastigium longer than broad and narrower proximad than distad, apex subtruncate when viewed dorsad, rather narrowly rounded when viewed laterad, the apex sometimes with a fine impressed medio-longitudinal line, fastigium of the face in contact with the fastigium of the vertex; eyes rather large, moderately prominent; antennæ at least three and a half times the length of the body. Pronotum with the disk not strongly flattened; cephalic margin subtruncate, caudal margin moderately arcuate; lateral shoulders present only on the metazona and there rounded, transverse sulci indicated but not deeply impressed; lateral lobes about as deep as long, cephalic margin obtuse-angulate, ventral margin subrectangulate, humeral sinus shallow and broad, convex callosity elliptical, distinct. Tegmina exceeding the genicular extremity of the caudal femora by nearly the length of the head, narrow, apex rounded on the costal margin, subtruncate on the sutural margin; tympanum of the male moderately large, slightly longer than the pronotum.

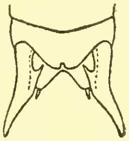

Fig. 10.—*Orchclimum militare* n. sp. Dorsal view of apex of male abdomen. (× 4.)

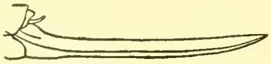

Fig. 11.—*Orchclimum militare* n. sp. Lateral view of ovipositor. (× 2.)

Wings extending beyond the tegmina by nearly the length of the head. Terminal dorsal abdominal segment of the male narrowly divided for nearly half its length; cerci elongate with a median obtuse angulation, the proximal half being robust and subcylindrical, the distal half being tapering, slightly falcate and distinctly depressed, the apex rather blunt, tooth on the internal margin mesad, directed strongly proximad, stout at the base, tapering, slightly curved; subgenital plate of the male cymbiform, keeled, hardly reaching to the middle of the cerci, the apical margin subrectangulate emarginate, styles short and tapering. Ovipositor over twice as long as the head and pronotum together, straight and subequal in the proximal two-thirds, tapering and very slightly curved dorsad in the apical third, apex acute and with its margins very faintly crenulate; subgenital plate rather short and broad, bullate, the immediate apex subtruncate. Caudal femora with the proximal half moderately inflated, in length about equal to two-thirds that of the tegmina, the external face with traces of a loricate pattern, ventral margins unarmed or with a single spine.

General color clay-color, distinctly green in life, some traces of the original color remaining; head varying from ochraceous to brick red, particularly along the median area of the face; dorsum of the pronotum and head marked more or less distinctly with a pair of fine ferruginous lines diverging caudad; eyes drab; antennæ raw umber finely annulate with vandyke brown, becoming uniform very dark brown distad.

Measurements.

	♂	♀
Length of body,	22 mm.	18 mm.
Length of pronotum,	4.6 "	4.5 "
Length of tegmen,	25.5 "	25.4 "
Length of caudal femur,	17.8 "	17.5 "
Length of ovipositor,		15.2 "

A single paratypic female has been examined in addition to the types. It is very slightly larger than the female type, but otherwise inseparable.

The three specimens secured were taken from a marshy sink-hole in pine woods.

Xiphidion fasciatum De Geer.

A series of twenty-four individuals represent this widely distributed form, taken as follows: Jacksonville, August 11, two males, three females; Gainesville, August 16 and 17, three males, four females; Cedar Keys, August 15, three males, eight females; Fairfax, Barnwell County, S. C., August 10, one male.

The environments represented are a city lot (Jacksonville), undergrowth in pine woods and sink-hole in the same (Gainesville), and open marsh (Cedar Keys).

Xiphidion nigropleurum Bruner.

Sixteen individuals are referred tentatively to this species, as there exists a possibility that one or more distinct species are included in the Florida material. The localities represented are: Gainesville, August 16, one female; Pablo Beach, August 11, one female; Cedar Keys, August 15, seven males, seven females.

When compared with Nebraska and Indiana males of undoubted *nigropleurum* the Cedar Keys individuals are as a rule larger; all belong to the brown form described by Blatchley,[17] with the pronotum very dark mesad. The tegmina are as rule somewhat shorter than in typical *nigropleurum* males and the cerci are slenderer and slightly more produced. Variability in the divergence of the apices of the latter is a very distinct feature, but otherwise the general form of the cercus is much the same in all the seven males.

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[17] *Orth. of Indiana*, p. 376.

The Florida females present very puzzling degrees of variation in the curve of the ovipositor. When compared with two Indiana females of true *nigropleurum* the ovipositor is seen to be slightly deeper in all the Florida specimens, straight as in the Indiana individuals in one Florida representative, very slightly curved dorsad at the apex in three and gently but appreciably curved in the remaining five. These types seem to shade one into the other, although the individuals with the ovipositor curved average somewhat larger, one, however, being no larger than in the opposite category. The tegmina vary from half the abdominal length to equal length, the latter seen only in one specimen. The variation in the ovipositor is irrespective of locality, both extremes having been taken at Cedar Keys. Until more evidence is in hand to prove the two extremes distinct, we are under the necessity of considering them purely variations within specific limits, and the same is true with the differences noted between the typical *nigropleurum* and the Florida forms or variants.

At Gainesville this species was taken in pine woods, and at Cedar Keys in salt marsh grass, where specimens were extremely abundant and although very active easily taken with the net.

The range of this species is here carried south from the Ohio Valley and New York State.

Odontoxiphidium apterum Morse.

A series of 101 specimens represents this very distinct genus and species, taken at the following localities: Pablo Beach, August 11, 12 and 13, thirty-five males, thirty-seven females; San Pablo, August 13, one male; Gainesville, August 16, twelve males, twelve females; Cedar Keys, August 15, three males, one female. Several specimens from each locality except San Pablo are immature, in some cases apparently two stages before the mature condition.

In size there is considerable variation, as previously evidenced by the measurements in the original description, while the color variations are almost wholly in the intensity of the median dark bar and in the extent of pale brown suffusion on the limbs.

A variety of environments are frequented by this species, ranging from dry palmetto scrub and undergrowth in pine woods to grassland, tall fresh marsh grass and salt marsh. The species was found most plentiful in the low parts of the open palmetto scrub at Pablo Beach. The insects were noticed to prefer the damp locations, but none were found in true marshlands. At Gainesville, also, specimens were abundant in the low places in the pine woods where the wire-grass was most luxuriant. Individuals were usually sufficiently inactive to be caught easily, with or without a net.

The range of this species now extends from Thomasville, Thomas County, and Brunswick, Glynn County, Ga., to Cedar Keys, Levy County, and Sanford, Orange County, Fla.

Atlanticus gibbosus Scudder.

Four adults, three males and one female, taken at Pablo Beach, August 11 and 14, represent this species. The individuals collected were taken in palmetto scrub and salt marsh and the species was not common.

As the information regarding this species is very meagre, measurements of an individual of each sex are here given.

	Pablo Beach, Aug. 11, 1905. ♂	Pablo Beach, Aug. 11, 1905. ♀
Length of body,	29 mm.	28 mm.
Length of pronotum,	13 "	12.5 "
Length of caudal femur,	32.2 "	34.5 "
Length of ovipositor,		29.2 "

This species possesses greater strength in the jaws than any other North American orthopterous insect known to us. A single bite can easily pierce the cuticle and cause the blood to flow. In consequence the field collector quickly acquires a wholesome respect for their defensive abilities. Individuals showed surprising activity in escaping when alarmed by seeking hiding places under the scrub palmettoes, to which they hurried with seeming ungainliness but nevertheless considerable speed.

GRYLLIDÆ.

Mogoplistes slossoni Scudder.

A single male individual was found August 12, in a bed at the hotel at Pablo Beach where the authors stayed. The specimen is considerably rubbed and in consequence the silvery scales of the perfect insect are almost entirely gone. The antennæ show no signs of annulations, but the limbs are supplied with imperfect and irregular rings of blackish brown and pale ochre.

The measurements of the specimen are as follows:

Length of body,	8 mm.
Length of pronotum,	2.8 "
Caudal width of pronotum,	2 "
Length of caudal femur,	4 "
Length of styles,	6.2 "

The range of this species now extends from the Biscayne Bay region north to Pablo Beach.

Liphoplus krugii Saussure.

This interesting species is represented by eleven individuals, adults and nymphs, representing two stages. The localities represented are: Pablo Beach, August 11, 12 and 13, two adult males, one immature male, three immature females; San Pablo, August 13, one adult male, two immature females; Gainesville, August 16, one immature male, one adult female. At Pablo Beach it was taken in grassland, under boards and beaten from weeds; at San Pablo and Gainesville it was found in the undergrowth in pine woods.

The adult male of this species has the pronotum considerably extended over the dorsum of the abdomen as in *Cycloptilum* and *Ectatoderus*, but the presence of a tambourine on the cephalic tibiæ as well as the divided interantennal process distinguishes *Liphoplus* from both of the allied groups. The measurements of an adult male and female are here given.

	Pablo Beach, Fla. ♂	Gainesville, Fla. ♀
Length of body,	8.6 mm.	8.2 mm.
Length of pronotum,	4.2 "	2.5 "
Length of caudal femur,	5.2 "	5.3 "
Length of ovipositor,		5.8 "

The species is now known to range north into Florida as far as Pablo Beach and San Pablo; Key West, the Bahamas, and Cuba being the only localities from which it has previously been recorded.

Nemobius socius Scudder.

Nine individuals represent this species, which possesses three phases rather similar to those of *N. fasciatus*. The localities represented are: Pablo Beach, August 11 and 12, two males, three females; Gainesville, August 16, one female; Bronson, Levy County, August 16, one male; Cedar Keys, August 15, one male, one female. At Pablo Beach it was found in wet and dry grass, and at Gainesville in the brush in pine woods.

The phases of this species are as follows: A long-winged type with the tegmina reaching nearly to the apex of the abdomen and the wings long caudate; another apparently wingless with the tegmina similar to the first form described; a third wingless and with the tegmina hardly reaching caudad of the middle of the abdomen. Each of these phases is represented by three individuals in the series before us, and, possibly by coincidence, all the three with the short tegmina are from the Gulf coast or drainage, the previously recorded specimens of this phase also being from that coast at Tampa.[18] However, one of the long-winged type is from Bronson, Levy County, not far from the Gulf, while both types described first are from Pablo Beach.

Some specimens are decidedly more blackish than others, and color pattern visible in the more brownish specimens is obliterated in the blackish individuals.

This species is known to range from Georgia south to Charlotte Harbor, Fla., and west to the Gulf coast of Texas.

Nemobius ambitiosus Scudder.

This species, probably the most attractive of our forms of the genus, is represented by a series of thirty-five individuals from the following localities: Pablo Beach, August 12, one immature female; San Pablo, August 13, one female; Gainesville, August 16 and 17, seventeen males, sixteen females. At San Pablo and Gainesville the undergrowth in pine woods was its favorite habitat, while at Pablo Beach it was found in palmetto scrub.

A very perceptible amount of variation in the shade of the base color of the tegmina and of the cephalic markings is noticeable, some individuals having these parts more brownish than others. The yellow line bordering the eye caudo-laterad is also absent or faint in several specimens, the same being true of the medio-longitudinal line on the external face of the caudal femora. In general size there is considerable variation, but the tegmina appear to be of a comparatively uniform length.

This species ranges from southern Georgia (Thomasville) to Miami, Dade County, Fla. The localities in addition to the above from which it has been recorded, all in Florida, are Leon County, Fort Reed and Sanford, Orange County; Jacksonville, Duval County; Ormond, Volusia County; Tampa, Hillsboro County; Charlotte Harbor and Indian River.

Gryllus rubens Scudder.

The localities at which this species was taken are Jacksonville, August 10, one male; Pablo Beach, August 13, one female; Gainesville, August 16 and 17, two males, one nymph. At Gainesville both the pine woods undergrowth and open field were the situations in which specimens were taken; at Jacksonville a city park, and at Pablo Beach grassland.

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[18] *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 50.

Œcanthus quadripunctatus Beutenmüller.

A male from Cedar Keys, August 15, and a female from Pablo Beach, August 13, represent this species. Both individuals were swept from grass.

Anaxipha exigua (Say).

A single male of this species was taken at Gainesville, August 16, from the wire-grass in pine woods, in company with *Falcicula*. In size it agrees with Pennsylvania and Delaware males.

Falcicula hebardi Rehn.

This sprightly little cricket was taken at but one locality, Gainesville, August 16. Here it was abundant in the wire-grass in long-leaf pine woods, apparently, however, quite local, and very elusive when located on account of its very protective coloration. As Gainesville was the only locality aside from San Pablo which is in any way similar to the type locality of the species, the lack of suitable environment was no doubt the reason it was not observed elsewhere. At San Pablo, our stay was too limited to be a fair test of the locality. The series captured comprises ten males, thirteen females and one nymph.

The range of this species in the southeastern States is from Thomasville, Thomas County, Ga., to Gainesville, Alachua County, Fla.

Hapithus quadratus Scudder.

A single male of this species was taken at Pablo Beach, August 11. When compared with males of *H. agitator* from New Jersey and Pennsylvania, the Florida form is seen to be larger with distinctly longer caudal limbs, the mediastine vein of the tegmen also having more numerous and more regular rami.[19]

Measurements of *quadratus* and *agitator* are as follows:

	agitator		*quadratus*	
	Riverton, N. J.	Tinicum, Pa.	Pablo Beach, Fla.	Miami, Fla.
	♂	♀	♂	♀
Length of body,	9.8 mm.	10 mm.	9.5 mm.	14.5 mm.
Length of pronotum,	1.5 "	1.8 "	2 "	2.5 "
Length of tegmen,	5.5 "	5.6 "	6.5 "	9 "
Length of caudal femur,	7.5 "	7.5 "	9.8 "	11.1 "
Length of ovipositor,		7.2 "		9.6 "

Hapithus brevipennis Saussure.

A series of four adult males and five immature individuals represent this species, the localities being Pablo Beach, August 12 and 13, two adults and two nymphs; San Pablo, August 13, one adult; Gainesville, August 16, one adult and two nymphs, and Cedar Keys, August 15, one nymph.

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[19] *Vide* Rehn and Hebard, *Proc. Acad. Nat. Sci. Phila.*, 1905, p. 52.

At Gainesville and San Pablo it was found in the undergrowth in pine woods, at Pablo Beach in palmetto scrub and along a railroad embankment, and at Cedar Keys in salt marsh.

The range of this species now extends from Louisiana to Georgia, south to Pablo Beach and Cedar Keys, Fla.

THE EMBRYOLOGY OF FULGUR: A STUDY OF THE INFLUENCE OF YOLK ON DEVELOPMENT.

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I. Introduction.

1. GENERAL.

It is generally believed that the accumulation of yolk in the eggs of certain animals has greatly modified their original manner of development. For example, selachians, reptiles and birds are probably derived from animals in which the eggs contained much less yolk than at present in these classes, and in which the development was different in many respects from that which now obtains among these forms. The effect of the loss of yolk upon development has been studied experimentally by Morgan (1893), but the influence of an increase in the amount of yolk, while the protoplasmic portion of the egg remains the same, has not been studied experimentally, and may perhaps lie beyond the test of experiment.[1] Such experiments, however, nature has performed in several different phyla of animals, but nowhere are natural conditions more favorable for a study of the influence of yolk on development than among the mollusks. Brooks (1879) long ago called attention to this fact, though it has not been reinvestigated in the light of the modern cellular study of development.

The comparison of the development of large eggs with that of small ones, with especial reference to the organization of the egg and the history of the cleavage cells, should be of considerable general interest. Does a great accumulation of yolk change the localization of morphogenetic processes and substances in the egg? Does it alter the developmental history and destiny of the blastomeres? Is the yolk itself localized in any definite germinal region of the egg? In what manner does a great mass of yolk alter the gastrulation and later embryonic development? These are questions upon which a detailed comparison of the normal development of large and of small eggs might be expected to shed some light. Undoubtedly experiments, if they could be successfully performed, would be of great value in answering these questions, but in the case of the gasteropods which I have studied I have not found it possible to test these questions experimentally.

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[1] The fusion of different eggs to form giants, such as occurs abnormally in certain cases, is not a case in point, since the relative amount of yolk and protoplasm remains the same in the fused eggs as in the single ones.

The development of gasteropods is extraordinarily varied in respect to the manner of nourishing the embryo and larva. In some cases, and these presumably the more primitive, the eggs are small and contain little yolk and the free swimming larvæ (veligers) are set free at an early age to shift for themselves (*e.g., Crepidula plana, Patella, Acmæa*, etc.). In others the eggs contain a larger quantity of yolk and the free-swimming life is correspondingly reduced (*e.g., Crepidula fornicata, Illyonassa*, etc.). In still others the eggs contain a yet greater quantity of yolk and the veliger stage is passed entirely within the egg capsules, the young escaping in practically an adult condition (*e.g., Crepidula convexa* and *adunca, Urosalpinx, Sycotypus, Fulgur*, etc.).

A most curious and interesting method by which nutriment is supplied to the embryo is found in those gasteropods in which a large number of relatively small eggs is laid, only a few of which develop, the others being eaten as food by the developing embryos (*e.g., Purpura, Buccinum, Fasciolaria, Neritina*, etc.).

For the purposes of the present study the only instances which we shall consider are those in which the food for the developing embryos is contained within the egg in the form of yolk. The early development of a considerable number of gasteropods is now well known, but most of these belong to that group having relatively small eggs. It has seemed to me worth while to compare with these the development of the largest gasteropod egg of which I have any knowledge, viz., that of *Fulgur carica*. The eggs of this species are about one-sixteenth of an inch in diameter; those of a closely allied form, *Sycotypus canalliculatus*, are about one-twenty-fifth of an inch in diameter. The eggs of *Fulgur* are about thirteen times the diameter and about 2,200 times the volume of the eggs of *Crepidula plana*, with which I shall particularly compare them. I have also studied several other species in which the eggs are intermediate in size between these two extremes, as shown by the following table:

Fulgur carica,	1,700 μ	in diameter.
Sycotypus canalliculatus,	1,000 μ	"
Crepidula adunca	410 μ	"
" *convexa*,	280 μ	"
" *fornicata*,	182 μ	"
" *plana*,	136 μ	"

The great difference in the sizes of these eggs is not due to a proportionate difference in all their constituents, viz., protoplasm as well as yolk, but almost entirely to the varying amounts of yolk which they contain, and this fact suggests the possibility of examining the influence of yolk upon development by comparing the development of one of the largest gasteropod eggs with one of the smallest.

A paper on the embryology of *Fulgur* was published by McMurrich (1886) more than twenty years ago. This paper deals in a general way with the development of this genus, questions of cell lineage and egg organization being at that time almost unknown. Further reference to McMurrich's work will be made throughout the course of this paper. A subsequent paper by the same author (1896) deals with the yolk lobe and centrosome of *Fulgur*. Some features in the development of this form were also considered by me (1897) in a paper dealing more particularly with *Crepidula*. Other than this the development of *Fulgur* has not been made the subject of any detailed study.

2. BREEDING HABITS.

For the sake of completeness I shall here mention some observations on the breeding habits of *Fulgur* and *Sycotypus*. In both of these forms the eggs are laid in peculiar disk-shaped or lenticular capsules which are attached in a series along a central cord. With the exception of the first few capsules formed, which are small and usually contain no eggs, each capsule contains from ten to twenty eggs embedded in a gelatinous substance which fills the capsules.

The method of forming the peculiar string of capsules characteristic of these genera is sufficiently interesting to merit a brief description. During the process of egg-laying, the foot of the female is contracted and partially withdrawn within the shell. A mucous-like secretion is then poured out from the nidamental organ through the folds of the partially contracted foot, and this secretion is applied to some solid object to which it adheres, or it is merely buried in the sand. In the case of *Fulgur* this first formed portion of the "string" is buried deeply in the sand; in certain specimens of *Sycotypus* which I kept in a wooden car, or float, the egg string was attached to the boards of the car. The first formed capsules on the string are small, far apart and contain no eggs. Later formed capsules increase in size and in the number of eggs contained in each, and successive capsules lie closer together on the string. During the process of laying the female is quiescent, and is usually buried beneath the surface of the sand, only the siphon protruding. The eggs, surrounded by the albumen and the secretion which forms the capsules, are poured out of the oviduct into a small cavity in the folded foot. Here the capsule-forming material comes into contact with the sea water and hardens, after which the capsule is released from the foot and another is formed. The average length of time taken by *Sycotypus* in forming a capsule is about three hours, and as the "egg string" may contain as many as seventy capsules, the egg laying may cover a period of several days.

The eggs of *Fulgur* are laid at Beaufort, N. C., during the months of May and June principally.[2] *Sycotypus* lays its eggs at Woods Hole late in August or early in September. The rate of development in these gasteropods is very slow. I can give no definite figures as to the length of the period of development, since the eggs which have been brought into the laboratory do not long continue to develop normally, but from such evidence as I have been able to gather I conclude that the development within the capsules occupies several months; indeed I have frequently found egg strings in midwinter with partially developed embryos, indicating that the eggs which are laid in the fall may not hatch until the following spring. As might be expected where eggs are so greatly laden with yolk, the entire embryonic and larval development is passed within the egg capsules and the young hatch in practically an adult condition.

3. METHODS AND MATERIAL.

The eggs of *Fulgur* and *Sycotypus* are very soft and are difficult to preserve. When removed from the very thick jelly in which they are enclosed within the capsules they usually flatten into thin disks under their own weight, or become otherwise distorted. There are no egg membranes except those formed by the surrounding gelatinous substance, and the thin pellicle of protoplasm which surrounds the egg is too weak to preserve the spherical shape or even to retain the yolk unless the eggs are floating in water or jelly. Since the jelly must in most cases be removed before the fixation of the eggs, special means must be employed to prevent them from bursting or becoming distorted. Many rapid fixing fluids, such as hot sublimate, alcohol and alcohol-acetic mixtures, cause the eggs to crack open, or even to split into fragments after they have been apparently well fixed. After experimenting with many fixing fluids, the only successful method of preservation which I have found, is to open one side of the capsule and place the capsule containing the eggs in the jelly in 20 per cent. formalin for an hour or two, and then shake the eggs out of the jelly into a mixture of 20 per cent. formalin and 70 per cent. alcohol, equal parts, afterwards transferring them to 80 per cent. alcohol. Unfortunately this method leaves shreds of the jelly adhering to the eggs, and as these shreds stain intensely they interfere with the study of the eggs, which are to be stained and mounted entire. To preserve eggs entirely free from the jelly I have found it advisable to slit open the jelly and allow the eggs to drop out into a tall jar of 20 per cent. formalin, or into a mixture of pure formalin (40 per cent.) and a saturated solution of corrosive sublimate, equal parts. If the jar is quite tall (at least eighteen inches) the eggs may be sufficiently hardened before they reach the bottom to preserve their spherical shape, especially if there is a layer of absorbent cotton at the bottom of the jar. After a preliminary hardening in this fluid the eggs may be transferred to other fixing fluids or to alcohol. These eggs were then stained in dilute Delafield's hæmatoxylin, and were mounted entire in the manner described by me (1897, 1902) for other kinds of eggs.

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[2] I wish here to acknowledge my indebtedness to Hon. George M. Bowers, U. S. Commissioner of Fisheries, and to Dr. Caswell Grave, Director of the Fisheries Station at Beaufort, for the many courtesies extended to me while I was at the Beaufort Station.

II. Cleavage.

1: THE UNSEGMENTED EGG.

I have made no attempt to study the phenomena of maturation and fertilization in these eggs since they are particularly unfavorable for such work, owing to the difficulties of fixation, already referred to, and to the great quantity of yolk, which make the eggs difficult to section.

The most striking feature of the unsegmented egg is the extremely small quantity of the nuclear and cytoplasmic material as contrasted with the yolk. The area of cytoplasm and the nuclear spindle shown in Plate XXIII, fig. 1, are but little larger than in the egg of *Crepidula*, though the entire egg of *Fulgur* is about 2,000 times the volume of the egg of *Crepidula*. The great increase in the size of the egg of *Fulgur* as compared with that of *Crepidula* is due almost exclusively to the increased quantity of the yolk.

2. FIRST AND SECOND CLEAVAGES.

It is one of the surprises connected with the development of this egg that although the yolk is so abundant the cleavage is yet holoblastic. When this work was first begun I had thought that the cleavage in this egg, which is larger than the eggs of many cephalopods, might show some resemblances to the meroblastic cleavage of the cephalopod egg. However, this is not the case, for the cleavages, at least as far as the 56-cell stage, are identically like those of *Crepidula* save for the enormous size of the macromeres. In the positions of the mitotic spindles, the direction and rhythm of division, and the shapes, relative sizes and number of the micromeres these two genera are practically identical. In the later development of *Fulgur* the yolk cells do not divide, although their nuclei do, and this may be an approach to the condition found in meroblastic eggs. Many characteristic differences appear between *Fulgur* and *Crepidula* in the later cleavages, and this fact is another evidence in favor of the view, which I have maintained elsewhere (Conklin, 1897, 1898), that the form of the early cleavage is more constant than that of the later cleavage; indeed the early cleavage pattern may be reckoned as one of the most conservative features in the development of any gasteropod.

The first cleavage divides the egg into two equal cells, one of which forms the anterior half of the future animal, the other the posterior half (fig. 2). At the close of this cleavage the nuclei and cytoplasmic areas rotate first in a dexiotropic and then in a læotropic direction, as in *Crepidula*, showing that the first cleavage is spiral in character.

During the first cleavage and again during the second a small lobe is formed at the vegetal pole, which again fuses with one of the macromeres at the close of the cleavage. This is the yolk lobe which has been observed in so many different animals. In forms in which the first two cleavages are equal this lobe is small, *e.g.*, in *Crepidula* it is quite inconspicuous, in *Fulgur* it is larger but still not more than one-sixth the diameter of the macromere; in forms in which the first two cleavages are unequal this lobe may be larger than the macromeres, *e.g.*, *Urosalpinx*. McMurrich mistook this lobe for the polar body, but afterwards (1896) corrected this mistake.

The second cleavage is at right angles to the first and divides the egg into right and left halves. It is not possible to affirm that the median plane of the future animal coincides precisely with the second cleavage plane, but it is evident that the two are very nearly, if not exactly, coincident. In this respect, as also in the læotropic position of the spindles and the relative positions of the daughter nuclei and spheres, this cleavage is similar to the corresponding one of *Crepidula*.

It is a surprising fact that a mitotic figure so small as that shown in fig. 1 can bring about the division of so large a cell. It does not seem possible that the mechanical influence of the amphiaster could cause so large a result, except as it may serve as a stimulus to other forces. It is doubtful too whether cytoplasmic movements of a vortical nature are sufficient to explain the division of a cell body in which there is so small an amount of cytoplasm and so large a quantity of yolk. The superficial layer of cytoplasm is so thin and weak that at first thought it would seem incapable of constricting and ultimately dividing this great cell. But although the factors named seem inadequate to produce so large a result it must be borne in mind that the yolk is relatively soft, almost fluid, and that a considerable quantity of cytoplasm is distributed through the yolk at this stage; furthermore the rate of division is extremely slow, many hours being necessary for the completion of each of the first two cleavages. These are the only equal divisions of the entire yolk which I have seen. Although the four macromeres give rise to many cells in the course of development they still constitute the chief volume of the embryo as late as the veliger stage (pl. XXVIII, fig. 31), thus showing that the yolk content of these cells has remained practically as in the 4-cell stage.

3. SEGREGATION OF THE GERMINAL LAYERS.

The third cleavage is very unequal and separates the first quartet of micromeres from the macromeres in a dexiotropic direction (pl. XXIII, fig. 4); these cells come to lie in the furrows between the macromeres, and their shape is consequently like the corresponding cells in *Crepidula*.

The fourth cleavage (fig. 4) separates the second quartet of micromeres from the macromeres in a læotropic direction. In anticipation of this cleavage the nuclei with the surrounding cytoplasm rotate læotropically until they lie in the upper left-hand corner of each cell, then the mitotic figures appear and the cleavage takes place precisely as in *Crepidula* and other gasteropods.

The first quartet cells then divide læotropically, giving off at their peripheral borders the "turret cells," and a little later the macromeres again divide in a dexiotropic direction, giving rise to the third quartet (fig. 5). Simultaneously the cells of the second quartet divide dexiotropically. These divisions are shown in figs. 5 and 6. As a result of these divisions twenty micromeres are formed, of which eight belong to the first quartet, eight to the second and four to the third (fig. 6). The entire ectoderm comes from these twenty cells. The micromeres are composed almost entirely of cytoplasm and are relatively free from yolk; in the macromeres the cytoplasmic areas surrounding the nuclei lie at the periphery of the cap of micromeres. The visible quantity of the cytoplasm has increased very considerably since the beginning of cleavage, as is readily seen by comparing figs. 1 and 6. This is probably due to the segregation of cytoplasm, originally distributed through the yolk, into the micromeres and cytoplasmic areas of the macromeres, rather than to the conversion of yolk into cytoplasm, since the yolk becomes less fluid and more firm during this period.

In *Fulgur* and *Sycotypus*, as in every other gasteropod so far studied, there are only three quartets of ectomeres. This is especially interesting in view of the enormous size of this egg, where we might expect, if anywhere, to find a much larger number of micromeres formed. McMurrich supposed that a large number of micromeres were budded off from the macromeres in *Fulgur*, and that the number of such micromeres varied with the size of the egg. Viguier (1898) and Fujita (1895) also reached the same conclusion, maintaining that the number of quartets formed in *Tethys* and *Siphonaria* is greater than three. This view is in my opinion wholly without foundation. Whether the egg be large or small three quartets of ectomeres are formed, no more and no less, and by the subdivision of the cells of these quartets all the ectoderm of the embryo is formed. In the cases cited by Viguier and Fujita it can readily be seen, from their own figures, that they have mistaken the subdivision of certain quartet cells for the formation of new quartets from the macromeres.

Since there are only three quartets of micromeres in *Fulgur*, and since these cells must overgrow the enormous yolk, it would seem reasonable to expect that the rate of subdivision of these quartets would be accelerated, as compared with forms in which the yolk is small. However this is not the case; the first quartet divides about the time of the formation of the second quartet, and the latter divides coincidently with the formation of the third quartet, just as in *Crepidula*. In much later stages the micromeres do divide more rapidly, but the early subdivisions of the three quartets is not more rapid in the case of this largest of gasteropod eggs than in the case of the smallest. In every respect except the size of the macromeres, the early cleavage of *Fulgur* is almost identically like that of *Crepidula* or any other prosobranch. In the number, position, shapes and relative sizes of the micromeres and in the positions and sizes of the nuclei and spheres there is the closest similarity between the largest and smallest of gasteropod eggs.

The next division is a highly characteristic one for annelids and mollusks, viz., the formation of the first member of the fourth quartet, 4*d*, by læotropic cleavage of the left posterior macromere.

After its formation it moves over into the furrow between macromeres *D* and *C*, as shown in pl. XXIV, fig. 8. This cell, 4*d*, is formed in advance of the other members of the fourth quartet and it contains a considerable quantity of yolk. In all of these regards it resembles the corresponding cell in all annelids and mollusks, with the exception of the cephalopods, in which the cell-lineage has been studied.

But the feature of particular interest in this cell is its destiny rather than its origin. In all annelids and mollusks, so far as known, the anterior portion of this cell gives rise to most of the mesoderm, while from its posterior portion the terminal part of the alimentary canal arises. This cell is therefore known as the mesentoblast. The history of this cell in *Fulgur* conforms entirely to what we know of it in other forms, as will appear later.

With the formation of the mesentoblast the segregation of the substances of the different germinal layers is nearly completed. I have not observed that the substances composing the mesentoblast differ visibly from those of the ectoblasts and entoblasts, except in the quantity of yolk which these different cells contain. But in *Limnæa*, *Physa* and *Planorbis* I have been able to distinguish the substance of the ectomeres from that of the mesomeres and entomeres before the first cleavage of the egg. In these fresh-water snails, therefore, there is a definite localization of the substances of the different germinal layers, and I have elsewhere shown reason for believing that it is the fact of this localization which determines that the ectoblast shall be separated in three quartets, and that the mesoblast shall arise from one cell of the fourth quartet. Since the segregation of the germinal layers occurs in exactly the same way in *Fulgur* as in these other gasteropods, it seems probable that there is here also the same type of localization of the germinal substances of the egg, and that the enormous accumulation of yolk in this egg has not altered in any fundamental way the localization of its various substances.

The other members of the fourth quartet, *4A*, *4B* and *4C*, are not formed until the 50-cell stage (fig. 9). They are much larger than the cell *4d* and contain a much greater quantity of yolk. Because of their great size I shall speak of them as the "secondary macromeres." These cells are purely entoblastic in character and give rise to a portion of the alimentary canal. In every one of these details they closely resemble the corresponding cells of *Crepidula*.

4. FURTHER HISTORY OF THE ECTOMERES.

The further history of the three quartets of ectomeres may now be followed through the development up to the time when they give rise to the first recognizable organs. About the time of the formation of the cell *4d* all of the twenty micromeres divide so that forty micromeres are formed, as shown in fig. 8 (in this figure all the micromeres have divided or are dividing except the two posterior turret cells, which divide a little later, fig. 9). The directions of these divisions and the relative sizes of the daughter cells is the same as in *Crepidula*, and the time at which the divisions occur is also the same, except that the turret cells divide earlier in *Fulgur* than in *Crepidula*.

The latest stage to which I have been able to trace with certainty the lineage of every cell is shown in fig. 9. At this stage there are present the following cells:

Ectomeres	42
Mesentomeres	6
Entomeres	7
Total	55

Fig. 10 shows spindles in two cells of the second quartet, and when the divisions here indicated are completed in the four quadrants the number of cells of known lineage is raised to 59. As a result of this work on the early cleavage it may be affirmed with confidence that in *Fulgur* the lineage of every cell up to about the 60-cell stage is identically like that of *Crepidula*.

a. The First Quartet.—Ectodermal Cross.—In *Crepidula* and many other prosobranchs one of the most striking appearances in the early history of the ectomeres is the formation of the so-called "ectodermal cross." This cross is composed of all the cells of the first quartet, except the turret cells, and of four cells of the second quartet, one of which forms the tip or terminal cell of each arm of the cross. The center of the cross lies exactly at the animal pole, and one of the four arms is anterior, one posterior, one right, and one left. This ectodermal cross, composed of exactly the same cells as in *Crepidula*, is present in *Fulgur* also (fig. 9 *et seq.*). It is not, however, so distinctly marked off from the other micromeres as in *Crepidula*, and it is therefore much more difficult to trace its subsequent history. In pls. XXIV, XXV, figs. 8–16, the outlines of the cross are shown in heavy lines, the center of the cross is marked by a short cross line, and the tip of each arm is lightly stippled. In fig. 8 the cross consists of three cells in each quadrant, an "apical," a "basal" and a "tip" cell (the anterior tip cell is not yet formed). In fig. 9 the basal cells in the right and left arms have divided, and in fig. 10 the basal cell of the anterior arm has also divided. There are at this stage four apical cells and three cells in each arm of the cross, except the posterior one which contains but two. Later, as shown in fig. 11, the basal cell in the posterior arm also divides and at this stage the cross consists of sixteen cells. Still later the apical cells bud off small cells between the bases of the arms, the "rosette" cells of *Nereis* and *Crepidula* (fig. 12). In every one of these details of cleavage the history of the cross in *Fulgur* is like that in *Crepidula*. The latest stage in which I have been able to identify all the cells of the cross is one slightly later than the one shown in fig. 12. At this stage the cross consists of the following cells:

Apicals	4
Rosettes	4
Basals	7
Middles	7
Terminals	4
Total	26

In later stages the entire cross cannot be recognized with certainty. In figs. 13–16 the center of the cross, where the apical cells meet, can be located, and the terminal cells may be seen more or less clearly, but the other cells cannot always be surely identified. In fig. 13 the arms of the cross can be plainly seen, each consisting of four cells in a single linear series, as well as the four derivatives of the turret cells which lie between the arms of the cross, but the apical and rosette cells cannot be identified. In fig. 14 the cross is scarcely apparent at all, and no part of it can be identified with certainty. In fig. 15 a cross is shown with four cells in a series in each arm, just as in fig. 13. Fig. 16 shows a central plate of cells surrounded by heavy lines which probably represents the cross; the center of the apical cells may be recognized, more or less doubtfully, at the place marked by the cross line, and the terminal cells are indicated by the stipples. Midway between the terminal cells on each side of the plate is a group of four cells, also enclosed in heavy lines, which are the derivatives of the turret cells. There are thirty-six cells in the cross in this latest stage in which it is recognizable, eight of which are derived from the second quartet. Deducting these second quartet cells and including the turret cells, we find that there are forty-four cells of the first quartet shown in pl. XXV, fig. 16.

In *Crepidula* seven large cells of the anterior arm of the cross form a peculiar "apical cell plate," while a number of large ciliated cells derived from the posterior arm and the posterior turret cells form a large "posterior cell plate," which becomes the head vesicle of the larva. In *Fulgur* none of these structures are visible at any time, and although the cross may be recognized clearly enough in its earlier stages, it is quite evident that it is not so definite a landmark here as in *Crepidula*, where its cells may be identified with great certainty up to a stage where it consists of sixty-six cells. The turret cells in *Crepidula* grow to an enormous size and remain undivided up to a stage with more than 100 cells; in *Fulgur* they do not become larger than the other cells of the first quartet, and they divide twice before the 100-cell stage, as shown in figs. 13 and 16.

b. Second and Third Quartets of Ectomeres.—As far as I have been able to follow the lineage of these cells in *Fulgur*, it coincides precisely with that of the same quartets in *Crepidula*. The first subdivision of the second quartet in *Fulgur* is shown in fig. 7; the first division of the third quartet and the second of the second quartet in figs. 8, 9 and 10. As a result of the divisions indicated in these figures two cells of the third quartet and four of the second are formed in each quadrant of the egg. By the divisions indicated in fig. 10 one additional second quartet cell is formed in each quadrant, and by the spindles shown in fig. 12 still another cell is formed, making six second quartet cells in each quadrant of the egg shown in fig. 12. All the third quartet cells then divide, as indicated by the spindles in two of the cells in fig. 11, thus giving rise to four third quartet cells in each quadrant. In figs. 12–16 there are six cells of the second quartet and four of the third in each quadrant. Every one of these ten cells has its homologue in the corresponding stages of the egg of *Crepidula*.

This is as far as I have traced the lineage of all the cells of the second and third quartets, though individual cells of these quartets may be recognized in later stages (fig. 17). These cells of the second and third quartets are in general larger than those of the first quartet, which they completely surround. The third quartet cells are especially large, and in some cases (figs. 13, 15, 16) are quite as large as the derivatives of $4d$.

In the stage shown in fig. 16 there are eighty-eight ectomeres as follows:

First quartet cells	44
Second quartet cells	28
Third quartet cells	16
Total	88

5. FURTHER HISTORY OF THE MESENTOMERES.

The cell $4d$, formed at the 24-cell stage by læotropic division of the macromere D, undergoes dexiotropic cleavage into two equal cells, $4d^1$ and $4d^2$ (fig. 9). At first these two cells lie to the left of the median plane, but they later shift position so that the plane of division between them comes to coincide with the plane of bilateral symmetry. The next division of these cells separates an anterior protoplasmic portion from a posterior yolk-laden one (fig. 9), and this process is repeated at a slightly later stage (fig. 12), thus giving rise to six cells derived from the cell 4*d*, three on each side of the median plane.

Of these cells the two anterior ones on each side are small protoplasmic cells which lie wholly under the layer of ectodermal cells; these cells give rise to the mesoblastic band of each side. The posterior cells are much larger and contain a considerable quantity of yolk; they are only partially covered by the cap of ectodermal cells (fig. 12); they ultimately give rise to the terminal portion of the intestine. I have not followed in detail the cell lineage of these cells in later stages, owing in part to the fact that they lie close under the thin layer of ectoderm, and it is frequently difficult to distinguish one from the other in surface views. However it is sufficiently evident that these cells show fundamental resemblances in origin, history and destiny to the mesentoblast cells of *Crepidula* and other gasteropods. The "mesoblastic bands" of *Fulgur* do not present a single series of cells, as in some annelids and mollusks, but rather a broad, irregular band of cells which has the general form of the letter Y. The stem of the Y lies in the median plane behind the area of the shell gland, while its two branches diverge on each side of this structure (figs. 19–24).

Some distance in front of the anterior ends of these bands a few cells appear beneath the ectoderm, which are probably the homologues of the "larval mesoderm" of other forms (figs. 19–22). They are in close relation to the ectoderm cells which give rise to the cerebral ganglia. I have not followed these "larval mesoderm" cells until they give rise to mesodermal structures, but have classed them as mesoderm because they lie beneath the surface and resemble in appearance the cells of the mesodermal bands.

6. THE ENTOMERES.

Up to a stage when there are approximately fifty cells in the entire embryo the entomeres consist of the four macromeres only. These macromeres are all of about the same size, and they contain an enormous quantity of yolk as compared with the amount of protoplasm. Each macromere contains an area of cytoplasm relatively free from yolk, in which lie the nucleus and sphere. These cytoplasmic areas lie as near as possible to the animal pole and to the free surface of the cell; with the extension of the cap of ectomeres these cytoplasmic areas with their enclosed nuclei and spheres are not overgrown by the ectomeres, but they move out over the yolk at the margin of the ectodermal cap, and this position they retain until the blastoderm has overgrown much of the yolk (pl. XXVII, fig. 26).

At a stage of about fifty cells, the macromeres *A*, *B*, and *C* divide in a laeotropic direction, giving rise to the remaining members of the fourth quartet, 4*A*, 4*B* and 4*C* (fig. 9). These cells are very large and full of yolk, and for these reasons I have called them "secondary macromeres." They come to lie in the furrows between the macromeres, and in this position they are partly overgrown by the advancing ectoderm and partly shoved before it. They serve as an excellent means of orienting the egg and embryo, since they are found at the right, left and anterior poles only, the posterior pole being occupied by the derivatives of the much smaller mesentoblast cell, 4*d*.

The secondary macromeres are purely endodermal in character. Although their nuclei subdivide (pls. XXV, figs. 17, 18, *et seq.*), their cell bodies usually remain undivided until the closure of the blastopore (pl. XXVIII, fig. 31). Throughout all of this period the entomeres consist of the four macromeres and of these three secondary macromeres. Even as late as the gastrula stage, shown in fig. 31, these are the only entoderm cells present except those derived from the cell 4*d*, which give rise to the terminal portion of the intestine (*In.*, figs. 29–31).

In *Crepidula* a fifth quartet of cells, which are purely entodermal in character, is formed from the macromeres about the time of the closure of the blastopore; and at the same time the cells 4*A*, 4*B* and 4*C* divide. These divisions have not been observed in *Fulgur*, but, with these exceptions, the origin, history and destiny of the entomeres of *Fulgur* are almost precisely like those of *Crepidula*. The four primary macromeres are similar in all regards, save only in bulk; the secondary macromeres arise at the same cell stage and behave in the same manner in these two genera. In *Crepidula*, as in *Fulgur*, these seven cells, together with the entoblastic derivatives of the cell 4*d*, constitute for a long period the whole of the entoblast.

With the stage represented by fig. 17, in which there are about 121 cells, the ectomeres become so numerous that their lineage cannot readily be traced. At a slightly later stage, regions of the blastoderm begin to differentiate into characteristic structures. We shall therefore consider this stage as the close of the cleavage and the beginning of the period of organ formation.

In conclusion we find that the cleavage of *Fulgur* resembles that of *Crepidula* in almost every detail. Such slight differences as do exist, as, for example, in the relative development of the "cross" in the two forms, are only such as frequently exist between other genera in which the eggs are about equal in size. In short the enormous size of the *Fulgur* egg, which has so greatly altered the relative proportions of cytoplasm and yolk, and of micromeres and macromeres, has not modified in the least the pattern of the cleavage. It has not modified the localization in the egg and the segregation in the cleavage of the substances of the germinal layers. In all of these respects the egg of *Fulgur* is typically like that of other gasteropods, and it shows no approach whatever to the condition found in the eggs of cephalopods.

7. RELATIVE SIZES OF NUCLEI AND CELLS.

The great quantity of yolk in the egg of *Fulgur* introduces some interesting cytological conditions. I have already called attention (p. 325) to the extremely small nuclear spindle in the first cleavage, and to the problem of how this little spindle and the small amount of cytoplasm around it can bring about the division of so great a cell body. Another, though related, problem is found in the relative sizes of the nucleus and cell body at different periods of the cleavage.

In all the early cleavages the nuclei and spindles are very small, even in the macromeres (figs. 1–6). Indeed the nuclei and spindles in the macromeres are not larger than those in the micromeres during the formation of the three quartets. After the formation of the third quartet (fig. 7) there is a relatively long resting period for all of the macromeres except *D*, consequently the nuclei in *A*, *B*, and *C*, fig. 8, have grown to nearly double the diameter of those in fig. 7. The macromere *D* divides before its nucleus becomes very large, giving rise to the mesentomere, *4d*. About the 50-cell stage, fig. 9, the macromeres *A*, *B*, and *C* divide, giving rise to the secondary macromeres *4A*, *4B*, and *4C*. The mitotic figures for this division are quite large and are proportional in size to the resting nuclei from which they arise.

From this stage onward the nuclei of all the macromeres enjoy a long "rest," during which they grow to double their maximum diameter at any previous stage (figs. 9–24). The greatest diameter of the nucleus during the 2-cell and 4-cell stages is about 40 μ; during the formation of the three quartets the nuclear diameter is not greater than this, but rather smaller; before the formation of the secondary macromeres (fig. 8) the diameter of the nuclei in *A*, *B*, and *C* is about 50 μ; at the close of their long rest and just before their next division (fig. 24) the nuclei are about 80 μ in diameter.

The diameter of the unsegmented egg is about 1,700 μ; that of each of the macromeres during the formation of the quartets about 970 μ; while in the stages after the formation of the fourth quartet it is somewhat less, say about 900 μ. Therefore, although the diameter of the cell body in these later stages is but little more than half that of the unsegmented egg, the nuclear diameter is twice as great as at any previous stage.

The ratio of the nuclear diameter to the cell diameter, the "Kernplasmarelation" (k/p) of Hertwig (1903), is about 1 : 40 in the unsegmented egg; about 1 : 24 in the 4-cell to 24-cell stages; about 1 : 20 just before the formation of the secondary macromeres; and about 1 : 12 at the close of the long resting period of the macromeres, shown in fig. 24.

In the micromeres of the 8–24-cell stages the ratio of the nuclear diameter to the cell diameter is about 1 : 5; and in the later stages, such as fig. 18, it rises to 1 : 3.

It seems perfectly evident from these figures that the absolute size of the nucleus is dependent not only upon the size of the cell, but also upon the length of the resting period; and by the same showing the length of the resting period is not determined primarily by the size of the nucleus. In all the earlier divisions of the macromeres of *Fulgur* the division comes on when the nucleus is relatively small (k/p = 1 : 24); in later stages it does not come on until the nucleus has grown to twice this size (k/p = 1 : 12).

In *Crepidula* I found (1902) that the size of the nucleus, chromosomes, centrosomes, spindles and asters was, in the last analysis, proportional to the volume of the cytoplasm, and I tried to show that the immediate cause of division was the growth of the nucleus to a point where the ratio of nucleus to cytoplasm exceeded a critical limit. This is certainly not the principal factor which brings on division in *Fulgur*; and the fact that mitosis may occur in one cleavage when the nucleus is relatively small and in another not until it becomes very large, suggests that the moment of division may be dependent upon some intrinsic condition in the nucleus or centrosome, rather than upon the ratio of nuclear size to cell size. Support is lent to this view by the phenomena of oogenesis; here we have in the germinal vesicle the largest nucleus in the entire life cycle, following upon one of the longest resting periods, while the second maturation division follows immediately after the first; here also the moment of division seems to depend upon intrinsic conditions in the cell.

In the division of the cell body *Fulgur* presents some interesting conditions. Attention has been called to the fact that although the spindle in the first cleavage is very small the entire egg divides. Equally surprising is the fact that in the divisions of the primary and secondary macromeres subsequent to the formation of the fourth quartet, the nucleus only divides while the cell body remains undivided (figs. 17–28). The cell bodies of these entomeres do not divide again until very late in development, if at all; even in figs. 34 and 35, in which the embryo shows many definitive structures, the furrow between two of the original macromeres can be seen running obliquely through the region below the head vesicle (*H. V.*).

It seems to me that the following explanation may be offered of this apparent anomaly. In the early stages of development the cell substance is quite fluid, as has been pointed out (p. 326), whereas in the later stages the substance of the macromeres becomes much more consistent. In the later stages of development the macromeres do not show the tendency to burst or to undergo distortion during fixation, which is so troublesome in the earlier stages; this is, I believe, due to the greater consistency of the yolk during the later stages. This same difference in consistency may explain also the curious fact that the entire cell divides in the early stages, whereas only the nucleus divides in later stages.

In this connection attention may be called to the fact that there is apparently a great increase in the quantity of cytoplasm in the later stages, as compared with the earlier ones (cf. figs. 1, 6, 25). This increased quantity of cytoplasm might be due to the liquefaction of the yolk and its transformation into cytoplasm, or it might be the result of the segregation into the ectodermal cap of cytoplasm originally spread through the yolk substance. It is probable that both of these processes occur, but in view of the increasing consistency of the yolk during the period of quartet formation, it seems very probable that most of the cytoplasm of the early stages was present as such, but in a diffused form, in the unsegmented egg.

III. Organogeny.

It has been shown that there are but few and minor differences between *Fulgur* and *Crepidula* in the cleavage up to a stage of about 100 cells (fig. 16). After this stage the differences in development become more marked. The first notable difference is found in the number of micromeres; by repeated divisions of the three quartets of ectomeres these cells become very numerous in *Fulgur*, as shown in figs. 17, 18, *et seq.*, whereas in *Crepidula* the number remains relatively small. It is evident that the same cell stages in the two no longer represent similar stages in differentiation; for example, the shell gland is one of the first organs to appear, and is first visible in *Crepidula* when there are about 250 cells present (Conklin, 1897, fig. 74); while it first becomes visible in *Fulgur* when there are about 1,000 cells (fig. 23). The period of the closure of the blastopore is very different in the two; in *Crepidula* this occurs before any organs are visible (fig. 65), in *Fulgur* only after almost all the larval and many of the definitive organs are present (fig. 31).

Other striking differences between *Fulgur* and *Crepidula* are found in the form and character of the different organs and in the time at which they appear, but most of all in the method of formation of these organs and in their relation to the yolk.

1. OVERGROWTH OF THE YOLK AND CONCRESCENCE OF THE EMBRYO.

Owing to the fact that the entomeres are so large in *Fulgur*, organs begin to differentiate long before the closure of the blastopore, indeed while the blastoderm is still a small cap at the animal pole of the egg (figs. 23–26). The organ bases are here spread out as in a mercator's chart, whereas in *Crepidula* the organ bases do not appear until the blastoderm has overgrown the yolk and they occur over the sphere, so that only a few of them can be seen from a single point of view.

In the earlier stages of *Fulgur* the organ bases occur in the anterior half as well as in the posterior portion of the blastoderm (figs. 21–23); later by the very rapid growth of the median anterior portion of the blastoderm these organ bases are displaced laterally and posteriorly until they come to form a kind of germ ring, or crescent, along the posterior margin of the blastoderm (figs. 24–28). This germ ring contains the bases of all the future organs, whereas the rest of the blastoderm forms a kind of yolk sac.

The manner of the overgrowth is represented diagrammatically in the accompanying text figure. The outlines of the blastoderm in successive stages of the overgrowth are indicated by the numerals 1–8. By superimposing on the same figure these different stages of the overgrowth it is possible to see at a glance the character and relative amount of the movement of the different organ bases. Thus in 1, the center of the blastoderm is approximately the center of the animal pole; in front of this lie the cerebral ganglia (*cb*) and velar row (*v*), while the buccal ganglia (*bc*) lie at the right and left margins of the blastoderm. Posterior to the animal pole is

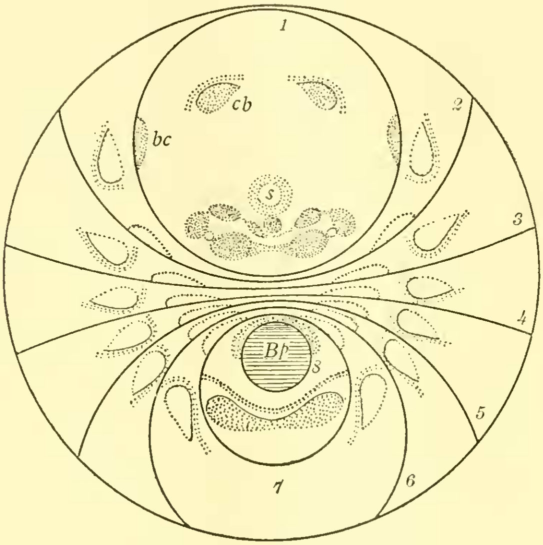

Diagram illustrating the more important phases in the overgrowth of the yolk by the blastoderm in *Fulgur carica*. The outer circle represents the outline of the entire egg, and the smaller circles, numbered 1 to 8, represent the margins of the blastoderm in successive stages of the overgrowth. The egg is represented as seen from the posterior pole, and in order to bring all stages into one figure the arc through which the posterior margin of the blastoderm moves is represented as less than is actually the case. The outline of the blastoderm and the positions of the organ primordia in stage 1 correspond to figs. 25 and 26, plate XXVII; stages 2 and 3 correspond to fig. 27; stage 4 to fig. 28; stage 5 to fig. 29; stages 6 and 7 to fig. 30; stage 8 to fig. 31. In stage 1 the velar cells are represented as a double line of stipples anterior and lateral to the cerebral ganglia (*cb*); the buccal ganglia (*bc*) lie at the lateral margins of the blastoderm; immediately posterior to the shell gland (*s*) is the primordium of the intestine; on the left of this is the abdominal ganglion, and on each side of the latter are the parietal ganglia, the pleural ganglia, the otocysts and the pedal ganglia. In stages 2–7 the cerebral and buccal ganglia are represented in dotted outlines; in stages 1 and 8 they are stippled, as are the other primordia.

found an organ complex which includes the shell gland, intestine, abdominal, parietal, pleural and pedal ganglia, and the otocysts.

By the growth of the median anterior portion of the blastoderm, the cerebral ganglia and velar cells and the buccal ganglia are carried around to the successive positions indicated in the diagram, while the organ complex described above undergoes little movement. The diagram is faulty in that it shows too little movement of the organ complex of the posterior lip, and thus represents the final position of the blastopore too near the posterior pole, but it represents fairly well the relative movements of the different organ bases during the first four stages shown (1–4). Reference to the first and second cleavage furrows between the macromeres, shown in figs. 25–28, will show that the posterior margin of the blastoderm remains relatively fixed during this period, while at the same time the blastoderm extends forward and laterally; still later the blastoderm extends posteriorly also, and finally the blastopore closes at the vegetal pole (fig. 30).

2. APICAL INVAGINATION.

The first structure which appears in the course of development is an invagination of ectodermal cells just anterior to the animal pole and in the region of the anterior arm of the cross. This invagination is preceded by a broad depression of the blastoderm (fig. 18), and then the center of this depression becomes deeply cup-shaped (fig. 19), and finally tubular in form (fig. 20). The axis of this tubular invagination at first runs forward under the ectoderm; then it becomes perpendicular to the surface of the blastoderm; and subsequently it runs backward under the ectoderm, its opening being at its anterior end (fig. 20). The inner, blind end of this invagination lies near the anterior end of the polar furrow, and in some instances, though not in all, a few cells are separated from the invagination at this point. The anlagen of the cerebral ganglia are formed on the right and left of this invagination, but they do not appear to be derived from it. Similarly a few mesoderm cells, which probably correspond to the "larval mesoderm" of other mollusks, lie on each side of the invagination, though they are not derived from it (see the black nuclei in figs. 19 *et seq.*).

Subsequently this conspicuous and definite structure completely flattens out and disappears (figs. 21 *et seq.*), leaving not a trace behind. This fact seems so remarkable and the significance of the invagination is so problematical that I have devoted considerable time and effort to the study of it.

It is evident that this invagination is not merely the result of the sinking in of the blastoderm over a cavity in the yolk. There is frequently a cavity between the macromeres, but this invagination invariably lies anterior to this cavity, and in many cases it actually forces its way into the substance of the yolk. In some cases also a prominent evagination is formed instead of an invagination, showing that there is very active growth in this region of the blastoderm.

It seems to me probable that this invagination is a mechanical adaptation to secure a rapid extension of the anterior half of the blastoderm over the yolk. During the growth of the invagination the area of the blastoderm remains stationary, or actually grows smaller; as soon as it flattens out there is a very rapid increase in the area of the blastoderm (cf. figs. 20 and 21), especially of that portion lying anterior to the first cleavage plane. Coincidently with this increase in area the secondary macromere, *4B*, begins to move forward in the furrow between the macromeres and the blastoderm rapidly extends forward. The remarkable extent of the growth of this anterior portion of the blastoderm may be seen by comparing the positions of the organ bases in figs. 19–30. In the earlier figures the shell gland and the two cerebral ganglia form the angles of an isosceles triangle, the base of which is directed forward (figs. 21 and 22); in later stages the ganglia separate more widely and the triangle becomes equilateral (figs. 23 and 24); still later the cerebral ganglia are separated so widely that they lie in line with the shell gland (figs. 27 and 28); and finally the cerebral ganglia again approach each other on the ventral side of the embryo (figs. 29 and 30). The greatest growth of the blastoderm takes place in the area between and in front of the cerebral ganglia, in the very region of the apical invagination, and it seems reasonable to suppose that the remarkable growth of this region is associated with the formation and subsequent flattening out of this structure.

McMurrich (1886) described at some length this invagination, and he compared it with a similar formation observed by Blochmann (1883) in *Neritina*, and by Sarasin (1882) in *Bythinia*. He says: "It seems very strange that an invagination so well marked as it is in *Neritina* and *Fulgur* should disappear and leave no trace of its existence, but so it seems to do." His further conclusion that it would be found to occur in most, if not all, of the prosobranch gasteropods has not been justified by later studies.

3. SHELL GLAND, SHELL AND MANTLE.

The shell gland is one of the earliest and largest of the developing organs, and is the one most instrumental in shaping the form of the embryo. It appears as an aggregation of ectodermal cells in the median plane posterior to the apical pole (figs. 21, 22). These cells, which are probably derived from the cell *2d*, increase greatly in number and form a saucer-shaped depression (figs. 23–26, *Sh.*). This depression then becomes deeper and smaller in surface area (figs. 27, 28) and subsequently it evaginates in the manner characteristic of gasteropods, the margin of the gland forming a ridge, the mantle edge, while the center is covered by the cuticular substance which forms the earliest shell; beneath this shell is a very thin layer of ectoderm, in which the nuclei are few and far apart. The margin of the shell gland, or mantle edge, is at first circular in outline; then it becomes uniformly elliptical (figs. 29 and 30); finally it continues to extend in all directions, except where it comes into contact with the organ complex on the ventral side of the embryo; here the growth of the mantle edge is arrested, and consequently a notch in the developing shell and mantle appears here, which notch grows deeper as the mantle edge extends farther (figs. 31–36).

The area covered by the shell grows larger continually and the yolk appears to slip through the ring formed by the mantle edge, while at the same time the blastoderm and its organ anlagen are retained in front of this ring. In this way the yolk slips out of the anterior portion of the embryo, and the tension on the blastoderm being relieved in this manner, the latter is free to undergo the foldings necessary to form the head vesicle, velum, larval kidney and heart; at the same time the mantle edge, continuing to grow forward on the dorsal side, gives rise to the mantle fold and mantle chamber. On the ventral side the forward growth of the mantle edge is stopped by the organ complex (figs. 35, 36).

In the earlier stages of this overgrowth, the mantle edge and organ complex are apparently bilaterally symmetrical; in later stages it can be seen that the organs are more developed on the right side (left in ventral view) than on the left, and consequently the notch in the mantle edge is displaced from the median plane toward the right. In this way the assymetry of this gasteropod makes its appearance. Along the left side of the notch (right in ventral view) a cellular thickening of the blastoderm occurs near the mantle edge (figs. 34, 35, *CmM.*) which gives rise to the columellar muscle, while the shell formed along this portion of the mantle edge is the columella.

It is well known that in annelids the ectoderm of the trunk is derived from the ectomere *2d* (= X). In *Fulgur*, *Crepidula* and several other gasteropods, cells derived from the ectomere *2d* give rise to the mantle edge and fold and to the layer of cells covering the yolk under the shell. This fact suggests that the elongation of the embryo through the ring of the mantle edge may possibly be comparable to the elongation of the trunk of the annelid.

4. NERVOUS SYSTEM AND SENSE ORGANS.

In their earliest stages the organ bases may be recognized by the fact that the nuclei are closer together and the protoplasm stains more deeply than in other portions of the blastoderm. In the case of the nervous system certain of the ganglia are from the first clearly distinguishable, whereas some others in the organ complex posterior to the shell gland (fig. 23) cannot be distinguished until a later stage.

a. Cerebral Ganglia.—The group of cells which will form the cerebral ganglia appears at a very early stage. It is shown in figs. 19 and 20 on each side of the apical invagination, and closely connected with the group of cells lying beneath the superficial layer, which I have identified, somewhat doubtfully, with the "larval mesoderm" (fig. 21, *Lm.*). The cells which give rise to the cerebral ganglia arise in the region of the blastoderm, on each side of the anterior arm of the cross and in front of the transverse arms, probably from the "rosette" cells, exactly as in *Crepidula,* and they probably correspond in origin as well as destiny to the cells of the "cephalic neural plate" of *Nereis* (cf. Conklin, 1897, p. 110).

With the great growth of the anterior part of the blastoderm, which follows the flattening out of the apical invagination, these cerebral ganglia are carried laterally until they lie near the margin of the blastoderm (figs. 21, 22, *Cb.*). In figs. 23 and 24 they lie still nearer the margin, and their protoplasm and nuclei are somewhat more condensed than in the previous stage; the bases of all the organs now stain more deeply and they are all connected together by deeply staining protoplasm (figs. 23, 24). In all these stages the cerebral ganglia lie anterior to the middle of the blastoderm and are the anteriormost organs present. Later they are carried back until they lie in the posterior lip of the blastopore and at opposite ends of a transverse line which lies nearly in the plane of the first cleavage, and along which line most of the organ bases of the embryo are found (text fig. and figs. 27, 28). Still later, by a continuation of the movement already described, the cerebral ganglia are carried posterior to the first cleavage plane and to the other organs of the posterior lip, and they then approach each other on the ventral side of the embryo, and come to lie on each side of the blastopore (figs. 29, 30). This movement of the cerebral ganglia may be better described by pointing out their position with reference to the shell gland, which may be considered as a fixed point. In earlier stages the shell gland forms the apex of an isosceles triangle, the other angles being formed by the cerebral ganglia; then by the separation of the ganglia the triangle becomes equilateral, and still later the angle at the apex increases until the ganglia and the shell gland lie in one straight line; then by a continuance of the movement of the ganglia a triangle is formed on the opposite (ventral) side of the shell gland, which develops in the inverse order of that on the dorsal side (text figure). In the stages shown in figs. 30 and 31 the cerebral ganglia lie lateral and slightly posterior to the blastopore; in fig. 32 they lie on the sides of the blastopore, and a process is growing out from each toward the other in front of the blastopore; in fig. 33–36 they lie in front of the blastopore and are closely connected together by the cerebral commissure.

Along the posterior edge of each cerebral ganglion a leaf-like process is formed which is the tentacle (figs. 35, 36, *T.*), and at the outer end of the furrow which separates the tentacle from the blastoderm the eye appears (figs. 34–36).

b. Buccal Ganglia.—Lateral and slightly posterior to each cerebral anlage is a group of cells which gives rise to the buccal ganglion (figs. 22, 23, *Bc.*). These cells lie at the very periphery of the blastoderm and are probably derived from the ectomeres 2*a* and 2*c*. In the overgrowth of the yolk they accompany the cerebral ganglia, moving from the dorsal to the ventral side in the posterior lip of the blastopore (figs. 27–29), and finally coming to lie along the posterior border of the blastopore (fig. 30). When the blastopore closes the buccal ganglia of the two sides come into contact on the posterior side of the blastopore (fig. 31 and text figure).

c. Pleural, Pedal, Parietal and Abdominal Ganglia.—The other ganglia of the nervous system form part of the complex of organs lying between the shell gland and the posterior lip of the blastopore. The pleural ganglia lie on each side of the shell gland and on the lateral borders of the organ complex (figs. 23, 24); the pedal ganglia lie on the median side of the pleurals; close behind the shell gland are the groups of cells which give rise to the parietal and abdominal ganglia. The anlagen of these ganglia are not clearly separated at this time, and only in the later stages (fig. 28 *et seq.*) are they quite distinct. When the foot begins to appear (fig. 31) the pedal ganglia are included within it, and the pleural ganglia lie on each side of the foot, while the otocysts lie between the two (fig. 28 *et seq.*). The otocysts are here, as elsewhere, formed as an invagination of the superficial ectoderm. All the ectodermal organs of this region are derived from the cell 2*d*, with the possible exception of the pleural ganglia, which lie on the lateral borders of the organ complex and may therefore come, in part, from the cells 3*c* and 3*d*. In annelids the ectoderm of the trunk region and the ventral neural plate, which gives rise to all the nervous system posterior to the mouth, come from this same cell, 2*d*, the "first somatoblast." Lillie (1895) found the same condition among lamellibranchs.

Among the gasteropods this cell is not larger than the other members of the second quartet, but it is destined to give rise to all the important ectodermal organs posterior to the mouth. In this fact we have a striking illustration not only of the value of cell-lineage in comparative embryology, but also of the fundamental similarity of annelids, lamellibranchs and gasteropods.

The parietal and abdominal ganglia, with their connectives, are recognizable as thickenings of the blastoderm in a stage as early as fig. 28, but they are not clearly distinguishable until a later stage (figs. 30, 33, 34). In these figures the entire nervous system is easily recognizable. The cerebral ganglia are connected by the cerebral commissure anterior to the mouth, and they are united with the pleurals and pedals by the cerebro-pleural and the cerebro-pedal commissures respectively on each side of the œsophagus. The parietal ganglion of the left side lies almost directly behind the foot, and is connected with the pleural of the left side by the pleuro-parietal connective; the parietal of the right side lies on the right side of the foot and is connected with the pleural of that side, while the two parietals are connected together by the nerve loop which runs alongside of the intestine and near its middle bears the abdominal, or visceral, ganglion.

In these and the following stages (pl. XXVIII, figs. 35 and 36) the entire nervous system and the twisting of the parietal loop may be seen with diagrammatic clearness. This twisting, which is a part of the general movement toward the right of all the organs posterior to the foot, carries the left parietal ganglion to the right side of the foot, where it lies in contact with the right pleural, while the abdominal lies still farther toward the right and the dorsal side (fig. 36); at the same time the right parietal is carried up to the dorsal midline, where it lies on the dorsal side of the œsophagus (fig. 36). The entire nervous system, except the buccal ganglia, which are here hidden from view by the cerebrals, is shown in very nearly its definitive position in fig. 36. All of the six pairs of ganglia may be recognized in fig. 30, and four pairs are recognizable in fig. 23.

In all of these regards the nervous system of *Fulgur* shows fundamental resemblances to that of *Crepidula*. To one who had not observed the earlier stages in the origin of the cerebral ganglia it might seem that these ganglia, which lie so near the periphery of the blastoderm and so closely connected with the other organs of the posterior lip, could not possibly have arisen from cells of the first quartet anterior to the transverse arms of the cross. It is only by a study of the early history of these ganglia and their subsequent movements that one can determine that the cerebral ganglia, and indeed all the ganglia, arise in corresponding parts of the egg in *Fulgur* and *Crepidula*. Such a study shows that amidst all the differences in the mode of development of these ganglia, there is the most fundamental resemblance in their places of origin in the egg, and that therefore the localization of the germinal substances of the egg in the early cleavage cells follows the same pattern in these two genera.

5. THE VELUM.

The velum arises in close relation to the cerebral ganglia, and its place of origin furnishes another striking illustration of what are apparently fundamental differences between *Fulgur* and *Crepidula*, but which are in reality fundamental resemblances. In *Fulgur* the velum is first visible as a dense band of nuclei on the median and posterior sides of the cerebral ganglia (fig. 28, *V.*). These velar bands are widely separated from one another and are entirely disconnected. In later stages these velar bands more completely encircle the cerebral ganglia; each has somewhat the form of a parabola, one limb of which runs forward in the lip of the blastopore, while the other, which lies posterior to the cerebral ganglion, runs out towards the lateral regions of the embryo and there ends in the general blastoderm (figs. 29, 30). Subsequently, when the blastopore narrows and closes, the two limbs which run forward in its lips unite in front of the mouth (figs. 31, 32), while the lateral limb turns forward over the sides of that portion of the embryo which will become the head vesicle (figs. 33, 34). From the posterior side of each band there is given off a branch which runs across the embryo posterior to the mouth and there joins its fellow of the opposite side, thus giving rise to the post-oral band, while that portion of the velum which runs in front of the mouth is the pre-oral band. Both of these bands were observed and described by McMurrich (1886).

In subsequent stages the velum is drawn out into a prominent bilaminar fold (figs. 35, 36). This velar fold or lobe grows out to a very great size, much larger than is shown in fig. 36, the ciliated velar cells being borne around its edge, as in other prosobranchs. By the beating of these cilia it is probable that the embryos are able to move very slowly within the egg capsules, though they never swim freely, the young escaping from the capsules only after the velar lobe has been absorbed. The velum in *Fulgur* is not a highly sensitive and contractile organ, as in *Crepidula* and in many other forms; apparently, it cannot be retracted, even in its most fully developed stage, and it is needless to say that in the stage shown in fig. 36 there is no cavity into which the velum, the head or the foot could be retracted.

From the preceding account it is evident that during the later stages of its development the velum in *Fulgur* is much the same as in *Crepidula* or any other prosobranch. In its early history, however, it seems to be altogether different. It appears, as has been said, on the median and posterior side of the cerebral ganglia when these structures lie far apart in the posterior margin of the blastoderm (fig. 28); in *Crepidula* it first appears about the time of the closure of the blastopore as a transverse row of cells in front of the mouth. In *Fulgur* it consists of two bands of cells on opposite sides of the embryo, which are entirely separate from each other; in *Crepidula* it is a single structure continuous from side to side.

However, in spite of these striking differences, it can be shown, I think, that the velum has a similar origin in both of these genera. Traces of the velum in *Fulgur* may be found at a much earlier stage than that shown in fig. 28; thus in fig. 23 a row of what I take to be velar cells may be seen on the lateral and anterior sides of the cerebral ganglia (the nuclei of these cells are shown in heavy outline). The position of this row of cells indicates that it has arisen from the cells adjoining the ganglion on the anterior and lateral sides, and since the ganglia themselves come, in all probability, from the "rosette" cells, the velar cells must have come from the anterior "turret" cells and perhaps also from the terminal cells of the transverse arms of the cross. In short, the velar cells arise in *Fulgur* in the same region and probably from the same cells as in *Crepidula*. Here again, as in the case of the cerebral ganglia, there is fundamental agreement between *Fulgur* and *Crepidula* in the early and late stages in the development of the velum; it is only in those stages of the overgrowth of the yolk, which are undoubtedly highly modified in *Fulgur*, that we find striking differences between these two genera.

6. BLASTOPORE, MOUTH AND ŒSOPHAGUS.

By the very great growth of the blastoderm in the region of the apical invagination the anterior portion of the blastoderm rapidly surrounds the yolk, while its posterior margin, containing all the organ bases, remains relatively fixed in position near the animal pole (figs. 25–28). Subsequently this posterior margin also extends over the yolk to such an extent that the blastopore finally lies at the vegetal pole of the egg (fig. 30). The anterior lip of the blastopore is always composed of an extremely thin layer of cells, and this portion of the blastopore is usually circular in outline; the posterior lip of the blastopore is always composed of a thicker layer of cells than the anterior lip, and it is not circular but is compressed laterally, as shown in fig. 30.

The blastopore then narrows until it is almost if not entirely closed (figs. 31, 32), and an invagination of ectoderm cells occurs here, which is the stomodæum. The mouth is formed at the very place where the blastopore closes, and the œsophagus is formed by the elongation of the stomodeal invagination (fig. 36, *Œ*.).

In the closure of the blastopore and the formation of the mouth and œsophagus *Fulgur* completely resembles *Crepidula*.

7. INTESTINE AND OTHER PORTIONS OF THE ALIMENTARY CANAL.

The intestine is formed from enteroblast cells derived from the mesentomere 4*d*. These enteroblasts lie in the midline behind the shell gland and they constitute the stem of a Y-shaped group of cells, the branches of the Y being the mesodermal bands (figs. 22, 23). In its earliest stages the intestine is a round, densely staining group of cells, which lies at a lower level than surrounding portions of the blastoderm. After the posterior margin of the blastoderm has extended over to the ventral side of the embryo, the intestine lies between the margin of the shell gland behind and the visceral nerve loop and abdominal ganglion in front (figs. 28–30).

About the time of the closure of the blastopore the anlage of the intestine elongates toward the right (left in ventral view), becoming at first elliptical in shape (fig. 31) and then tubular (fig. 32 *et seq.*). Up to the time of this elongation it lies in the median plane; after this it, together with other organs posterior to the foot, moves to the right. The end of the intestine which remains nearest the midline is the anal end, though the anus does not form until a much later period; the end farthest to the right is the gastral end. The intestine lies just in front of and parallel with the edge of the shell; in fig. 32 its course is nearly transverse to the long axis of the embryo, the notch in the shell being at this stage very shallow. As the shell grows forward on the dorsal side more rapidly than on the ventral, this notch grows deeper, and the right edge of the shell becomes parallel with the long axis of the embryo (figs. 33–35); at the same time the intestine turns from a transverse to a longitudinal course. The visceral nerve loop accompanies the intestine in this movement, the abdominal ganglion always lying close to the mesial side of the intestine.

Finally the mantle cavity begins to form on the mesial side of the intestine, and the latter is thus carried into the roof of the mantle chamber, the anal end of the intestine remaining near the mantle edge, while the gastral end reaches to the deepest portion of the mantle chamber (fig. 36). In all of these details as to the formation of the intestine there is striking similarity between *Fulgur* and *Crepidula*.

In *Crepidula* the gastral end of the intestine opens into a lumen between the yolk cells, which give rise to the stomach and liver. In *Fulgur* I have observed no such lumen between the yolk cells, and while I think it probable that these cells form the stomach and liver in this animal, I have not traced their history far enough to speak with certainty upon this point. In *Fulgur* as in *Crepidula* the secondary macromeres lie at the inner end of the stomodæum (fig. 31), and they probably form that section of the alimentary canal immediately following the stomodæum.

8. THE FOOT.

The development of the foot is practically the same in *Fulgur* as in other prosobranchs. It appears as a thickening of that portion of the blastoderm lying between the otocysts behind, the blastopore in front, and the pedal ganglia on the sides (figs. 29 and 30). It is at first wide in transverse direction and narrow antero-posteriorly and it is bilobed, the two lobes being separated on the side of the blastopore by a groove in which the blastoderm remains thin (figs. 30 *et seq.*). The foot then gradually rises above the general level of the blastoderm until it becomes prominent, becoming about half as wide from side to side as in earlier stages (figs. 33, 34); at the same time it takes into itself the pedal ganglia and otocysts.

At the posterior end of the groove between the two lobes an invagination is formed which becomes the pedal gland (*P. G.*, figs. 33, 34). A transverse furrow on the surface of the foot then constricts off a smaller anterior lobe, the propodium, from a larger posterior one, the mesopodium and metapodium (figs. 35, 36).

9. LARVAL AND DEFINITIVE KIDNEYS.

Running laterally from the foot a ridge of cells develops on the right and left sides; this ridge lies some distance posterior to the velum, with which it is nearly parallel; its free border, or crest, becomes crenated (figs. 34, 35, *Ex.K.*). This is the larval or external kidney and, as in other prosobranchs, consists of large ectodermal cells which become loaded with nitrogenous waste substances. It is an interesting fact that the larval kidney of *Fulgur* does not appear until after the basis of the permanent kidney is present (figs. 32, 33), and its relatively small size seems to indicate that it is never an important excretory organ in this animal. I have not observed the destiny of these excretory cells in *Fulgur*, but in *Crepidula*, where they are relatively larger, they are ultimately pinched off and set free with their load of nitrogenous waste. In *Fasciolaria*, as Glaser (1905) has shown, the external kidneys become colossal organs, which are filled with nitrogenous waste substance. Here the great size of these organs is probably associated with high metabolism of nitrogen, the result in this case of the cannibalism of the embryo. The small size of these organs in *Fulgur* probably indicates low nitrogenous metabolism in the embryo.

The definitive kidney has no structural connections with the larval ones. It appears as a single structure near the gastral end of the intestine (figs. 32 *et seq.*), and a duct develops from it which runs along the right side (left in ventral view) of the intestine (figs. 34, 35). As a result of the invagination which forms the mantle chamber, both the kidney and the intestine come to lie in the roof of that chamber, and since the kidney lies near the edge of the mantle it undergoes little movement during this invagination; the intestine, which lies farther from the mantle edge, moves under the kidney during this invagination, and thus the relative positions of these two organs are interchanged, the kidney coming to lie on the left side of the intestine (fig. 36).

10. GILL AND HEART.

At its earliest appearance the gill lies on the anterior side of the kidney and in close contact with it (figs. 33, 34). Before the formation of the mantle chamber it is merely an aggregation of cells and shows no characteristic structure. After the formation of the mantle chamber it lies on the left side of the kidney and its anterior border becomes crenated, each of these lobules giving rise later to a tentacle-like process.

The larval heart (figs. 35, 36, *L.H.*) appears as a blister under the blastoderm at the right of the larval kidney (fig. 34). The walls of this vesicle contain smooth muscle cells and are pulsatile. I have observed no definite vessels leading to or from this heart, and it probably serves merely to keep lymph moving through irregular channels. In later stages the larval heart is carried up on to the dorsal side of the embryo behind the head vesicle and velum (fig. 36): this movement is a part of the general twisting of all the organs, which were originally posterior to the foot.

I have not observed the manner of origin of the definitive heart and have not been able to recognize its anlage, unless it may be the dark body between the reference letters *M* and *Pa* in fig. 36.

IV. CONCLUSIONS.

The development of the principal organs and organ systems of *Fulgur* has now been described, with especial reference to their cell-lineage and topographical relations. It has not been possible to trace the entire cell-lineage of any organ, owing to the very large number of cells which are present before organs appear, but it is possible to determine the quartet and usually the individual cell of the quartet from which any organ arises. In a few cases (cerebral ganglion, velum, intestine) organs may be traced back to individual cells of a stage much later than the quartet formation, but in no case is it possible to observe every division of the cells which enter into the formation of an organ. This lack of a complete knowledge of the cell-lineage is not peculiar to *Fulgur*, but is general among forms in which the cell-lineage has been studied, and it is not a great hindrance to the study of the localizations of morphogenetic substances and processes of the egg. If groups of cells which give rise to certain organs can be traced back to certain quartet cells, this is usually sufficiently detailed information as to the cellular origin of an organ. In *Fulgur* it is unusually easy to trace this connection between blastomeres and organs, owing to the fact that the organs appear while the blastoderm is still a flat plate.

Next to the resemblances between *Fulgur* and *Crepidula* in the early cleavages, there is no similarity between these forms more striking than that which is found in the cellular origin of homologous organs. Although the organs of these two genera may differ widely in size and early position, there is not a single instance in which there is any good reason for supposing that these organs have arisen from unlike cleavage cells of the early stages. On the other hand, there is the best of evidence that homologous organs in *Crepidula* and *Fulgur* arise from corresponding cells of the different quartets, and even from corresponding cells of much later stages (60-cell stage), even though in still later stages these organs may occupy widely different regions of the embryo, as in the case of the cerebral ganglia.

With regard to the later cleavages, it is not only impossible to follow the lineage of individual cells until they give rise to organs, but it is certain that the cells of these two genera cannot be individually compared, since there are many more cells in *Fulgur* at a given stage of differentiation than in *Crepidula*. For example, there are about 250 cells in the embryo of *Crepidula* at the time of the first appearance of the shell gland, in *Fulgur* there are about 1,000 cells, and in any comparison of the cells at this stage it must be remembered that in general four cells of the latter are equal to one of the former. Not only does the number of cells differ in corresponding stages of differentiation in these two forms, but even in the same species there are variations and irregularities in the later cleavages which are not present in the earlier ones. When these irregularities of the later cleavages are compared with the invariable features of the early ones, such as the segregation of the ectoderm in three quartets of cells and the origin of the mesoderm of the trunk region from one cell of the fourth quartet, it is impossible to avoid the conclusion that the early cleavages are of greater morphogenetic value than the later ones. Furthermore, the conditions found in *Fulgur*, as compared with those in *Crepidula*, show that neither the presence of a large amount of yolk in the egg before cleavage, nor the modifications of the later stages, due to the presence of this yolk, affect the localization of the morphogenetic materials and processes in the earlier stages. The conclusion seems to be justified that the type of this localization is a more general and fundamental character than the form of gastrulation, or any other relatively late process in the ontogeny.

In *Fulgur* as in many other animals the egg shows polar differentiation while it is still in the ovary, and even before yolk formation begins. The yolk is laid down in all parts of the egg, and before maturation one pole is not noticeably richer in protoplasm than another. With the maturation of the egg the segregation of the protoplasm and yolk begins, most of the protoplasm passing to one pole and becoming the future ectoderm, while the yolk remains at the opposite pole and with a relatively small amount of protoplasm gives rise to the endoderm. In the first two cleavages this yolk is distributed equally to the four quadrants of the egg, and since the blastopore forms at the vegetal pole, the ectoderm must extend equally (but not synchronously) over the yolk in all directions. In the early stages of this overgrowth the anterior portion of the blastoderm extends more rapidly than the posterior portion, and by this means the cerebral and buccal ganglia are brought into close relation with the other organs present in the posterior margin of the blastoderm.

In many animals the yolk is not distributed equally to the four quadrants of the egg (*e.g.*, *Urosalpinx*, *Nassa*, *Dentalium*, *Chætopterus*, etc.), and wherever this is the case a "yolk lobe" of considerable size is present. When one macromere is much larger than the others a large yolk lobe is attached to it; when the cleavage is approximately equal the yolk lobe, if present, is small. Crampton (1896) has shown that the removal of the yolk lobe causes the absence of mesoderm in *Illyonassa*; and in his beautiful "Studies on Germinal Localization" Wilson (1904) has found that when the polar lobe of *Dentalium* is removed the resulting larva lacks the post-trochal region and probably also the mesodermal bands. Both of these authors found that following the removal of the lobe the four quadrants of the egg were equal in size. It cannot be assumed that the size of the lobe is proportional to the size of the somatoblasts 2*d* and 4*d*, or to the size of the post-trochal region, or to the quantity of mesoderm which is formed later. In *Fulgur*, *Crepidula* and all other cases in which the quadrants are nearly equal in size, the yolk lobe is much smaller than the post-trochal region or the mesentomere 4*d*, or even the mesodermal bands; while in *Illyonassa*, *Tritia*, and other forms in which one of the macromeres is much larger than the others, the yolk lobe is much larger than the cell 4*d*. On the other hand the lobe is usually associated with unequal division of the yolk, and its size is proportional to that inequality. Therefore I believe that the real significance of the yolk lobe is to be found in its relation to equal and unequal cleavage.

Since the blastopore forms at the vegetal pole in all gasteropods, so far as known, unequal division of the yolk must lead to unequal growth on the part of the blastoderm; if the posterior macromere is large the overgrowth must be greater in a posterior direction than in any other; if the anterior macromere is larger than the others, as in certain opisthobranchs, the blastoderm must grow more anteriorly than posteriorly. When all the macromeres are equal the overgrowth must take place equally in all directions, though the case of *Fulgur* shows that it may be accelerated at one time in one portion of the blastoderm and at another time in another portion.

The most striking difference between *Fulgur* and other gasteropods is found in the manner of this overgrowth, and consequently in the manner in which the different organ bases are carried from their point of origin to their definitive positions in the embryo. In both the point of origin and the definitive position of the various organs there is fundamental agreement between *Fulgur* and *Crepidula*, but in the manner of passing from their point of origin to their final position there is marked dissimilarity. In *Crepidula* the region of greatest growth of the blastoderm lies on the dorsal side between the anlagen of the cerebral ganglia and the shell gland; in *Fulgur* it lies anterior to the cerebral anlagen. In *Crepidula*, as a result of this condition, the cerebral ganglia are carried forward around the anterior end of the embryo until they come to lie anterior to the mouth on the ventral side. In *Fulgur* the same ganglia are carried backward around the yolk until they finally reach the same position on the ventral side of the embryo.

It has been customary hitherto to regard such peculiarities of the embryo as primary, and the associated peculiarities of cleavage stages as secondary adaptations to these later appearing peculiarities; but this puts the cart before the horse. The adaptations of cleavage are adaptations to conditions pre-existing in the egg, and not adaptations to conditions which appear later in the embryo or adult. Given the enormous yolk of *Fulgur* or the small yolk of *Crepidula plana,* and the embryo must adapt itself to these conditions of the egg; or, in other words, the earlier conditions in ontogeny stand in the relation of cause to the later conditions, and not the reverse.

When I first observed in *Fulgur* the great modifications in the location of organ bases, which is unlike anything hitherto described, and found, for example, that the cerebral ganglia and velum were located in the posterior lip of the blastopore, I thought, for a time, that here was a new pattern of germinal localization, and that the generalization that homologous structures always come from homologous regions of the egg had broken down. Further study has shown that this is not the case, and that the great modifications in the location of embryonic organs in *Fulgur* are not primary but secondary, while the localization pattern in the early cleavages is the same as in other gasteropods.

Hence I regard the case of *Fulgur* as a triumph for the method and doctrine of cell-lineage. Those who see in this method only 'the counting of cells,' 'mitotic book-keeping,' 'the drudgery of dull minds,' have missed the whole point and significance of this method, which is not to name every cleavage cell, but to determine in what areas of the egg certain morphogenetic processes are located. To know that such processes may be localized in the egg is valuable information, even though the pattern of this localization should differ for every animal; but to have discovered that through all the multifarious modifications which are found in the embryos and adults of great animal classes, such as the gasteropods or annelids, this same pattern runs unchanged,—this is illuminating.

SUMMARY.

1. The eggs of *Fulgur carica* are among the largest of gasteropod eggs, their relatively great size being due almost exclusively to the great quantity of yolk which they contain. These eggs are thirteen times the diameter and about 2,000 times the volume of those of *Crepidula plana,* with which particularly they are compared.

2. The cleavage of the egg of *Fulgur* is, cell for cell, like that of *Crepidula* up to the 56–60-cell stage, the only difference being in the

relative sizes of the macromeres in these two genera. Some of the individual features in which the cleavage of *Fulgur* resembles that of *Crepidula* are the following:

a. The direction, rhythm and quality of each cleavage is the same.

b. The first and second cleavages are equal; the first is transverse to the median plane of the embryo, the second coincides with that plane; a small yolk lobe is formed during each of these cleavages.

c. The ectoderm is segregated in three quartets of micromeres.

d. The first formed member of the fourth quartet, 4*d*, is the mesentomere; its anterior portion gives rise to the mesodermal bands and its posterior portion to the intestine.

e. The remaining members of the fourth quartet, viz., 4*A*, 4*B*, 4*C* are entomeres and give rise to all portions of the alimentary canal and its outgrowths, save the intestine and stomodæum.

f. The first quartet of ectomeres forms a "cross", with its centre at the apical pole and with anterior, posterior, right and left arms. Between the arms are the "turret" cells, and between these and the apical pole are the "rosette" cells; all of these cells are derived from the first quartet, except the "terminal" cells of the arms which are derived from the second quartet. The cross is formed of exactly the same cells in *Fulgur* as in *Crepidula*, but it is neither so distinct in form nor so persistent.

g. The second and third quartets surround the first and are composed of cells which divide in the same order and direction as in *Crepidula.*

3. In later cleavages many more ectoderm cells are formed in *Fulgur* than in *Crepidula* at corresponding stages of differentiation.

4. The overgrowth of the yolk is highly peculiar in *Fulgur.* By very great extension of the anterior half of the blastoderm, while the posterior half remains relatively fixed, all the organ bases are carried to the posterior margin of the blastoderm, where they form a kind of germ ring. Subsequently the posterior margin also moves over the yolk, so that the blastopore is finally formed at the vegetal pole.

5. Before the extension of the anterior portion of the blastoderm an apical invagination of ectoderm cells is formed in the region of the anterior arm of the cross. This invagination subsequently flattens out and completely disappears. Its function seems to be connected with the rapid extension of this part of the blastoderm.

6. The cerebral ganglia arise on each side of the apical invagination, probably from the anterior "rosette" cells. The velar cells arise around the outer margins of the ganglia, probably from the anterior

"turret" cells. By the rapid growth of the anterior portion of the blastoderm these organ bases are forced far apart and posteriorly until they come to lie in the posterior margin of the blastoderm, and by a continuation of this movement they are carried around to the ventral side of the embryo, where the two halves of these organs approach each other and finally unite in front of the mouth.

7. The paired buccal ganglia arise lateral to the cerebral and probably from derivatives of $2a$ and $2c$; they extend over the yolk in the same manner as the cerebrals and finally concresce on the ventral side of the embryo posterior to the mouth.

8. All other organs (shell gland, pedal, pleural, parietal and abdominal ganglia, foot, intestine, kidney, gill, heart, etc.) arise from the median posterior portion of the blastoderm, and chiefly, if not entirely, from the two "somatoblasts," $2d$ and $4d$. The bases of all of these organs, except the last three, appear when the blastoderm is still a small plate, and in the case of paired organs they are from the first connected across the median plane and do not, therefore, undergo concrescence. The origin of these post-oral organs from the two somatoblasts is strikingly like the condition found in annelids, and the elongation of the body of the gasteropod through the shell gland is similar to the elongation of the body of the annelid.

9. All homologous organs arise from corresponding cleavage cells in *Fulgur, Crepidula*, and probably all other gasteropods. Great increase in yolk does not modify the type of germinal localization, though it does profoundly modify gastrulation and later stages.

10. This indicates that germinal localization in the egg and in the cleavage stages is more fundamental and primitive than are the later processes of ontogeny.

CYTOLOGICAL.

11. During quartet formation the nuclei of the macromeres divide at relatively short intervals and they remain relatively small, the ratio of maximum nuclear diameter to cell diameter ("Kernplasma-relation" K/p) being 1 : 24. In later stages the resting period of the nucleus is very long and the ratio rises to 1 : 12. The size of the nucleus is therefore dependent not only upon the size of the cell, but also upon the length of the resting period. There is in this species no fixed ratio of nuclear size to cell size, and the cause of cell division cannot be found in the maintenance of a constant ratio.

12. After the formation of the fourth quartet the macromeres do not again divide, although the nuclei do. In the first and second cleavages the macromeres divide equally; this apparent anomaly is

probably due to the fact that cytoplasm is distributed through the yolk in the early stages and is lacking in the later ones. This suppressed cleavage of the yolk in the later stages is an approach to the condition found in meroblastic eggs.

References.

No attempt is made in this paper to review recent important contributions on cell-lineage, foremost among which must be mentioned the important memoirs of Robert (1903) on Trochus, Wierzejski (1905) on Physa, and Carazzi (1906) on Aplysia. The papers here listed are those mentioned in the body of this work.

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Reference Letters.

A, *B*, *C*, *D*, Macromeres.
1a, *1b*, etc., First quartet cells.
2a, *2b*, etc., Second quartet cells.
3a, *3b*, etc., Third quartet cells.
4d, Mesentoblast.
4A, *4B*, *4C*, Secondary macromeres.
A.I., Apical invagination.
Bp., Blastopore.
Cb., Cerebral ganglion.
Bc., Buccal ganglion.
Pl., Pleural ganglion.
Pd., Pedal ganglion.
Pa., Parietal ganglion.
Ab., Abdominal ganglion.
E., Eye.
G., Gill.
H.V., Head vesicle.
I., Intestine.
K., Kidney.
Ex.K., Larval kidney.
L.H., Larval heart.
L.M., "Larval mesoderm."
M., Mantle.
Ms., Mesodermal bands.
O., Otocyst.
P.G., Pedal gland.
Sh., Shell gland.
T., Tentacle.
V., Velum.
Cm.M., Columellar muscle.
Oe., Œsophagus.

DESCRIPTION OF PLATES XXIII—XXVIII.

All the figures were drawn at the stage level with the aid of the camera lucida; plates XXIII, XXVII and XXVIII under Zeiss Apochromatic Obj. 16 mm., Oc. 4; plates XXIV, XXV and XXVI with Obj. 8 mm., Oc. 4. The figures of the former plates are therefore magnified 62 diameters; of the latter, 124 diameters. In the process of reproduction the figures were reduced a little more than half, so that as they appear on the plates they represent a magnification of about 30 diameters and 60 diameters respectively. All the drawings are of eggs or embryos of *Fulgur carica*, fixed, stained and mounted as described in the first section of this paper.

PLATE XXIII.—Entire eggs; 1-cell to 24-cell stages.

Fig. 1.—Unsegmented egg, showing first cleavage spindle and surrounding cytoplasm.

Fig. 2.—Two-cell stage, showing læotropic turning of cytoplasm, nuclei and spheres preparatory to the second cleavage.

Fig. 3.—Four-cell stage; the positions of nuclei and spheres indicates that the transverse furrow is here the second one.

Fig. 4.—Eight-cell stage, showing first quartet of micromeres which have turned in a dexiotropic direction; in two of the macromeres are nuclear spindles for the formation of the second quartet, which arises in a læotropic direction.

Fig. 5.—Sixteen-cell stage. The first quartet has divided læotropically, giving rise to the "apical" cells centrally and the small "turret" cells peripherally. The second quartet cells are dividing in two quadrants, and the third quartet cells are arising dexiotropically from the micromeres.

Fig. 6.—Twenty-four-cell stage, resulting from the completion of all the divisions initiated in the preceding figure.

PLATE XXIV.—Blastoderms during the earlier stages of cleavage.

Fig. 7.—Same stage as shown in fig. 6, but magnified twice as much; twenty micromeres and four macromeres; the separation of the ectoderm from the macromeres is now complete.

Fig. 8.—Forty-five-cell stage. Every cell of the preceding stage has divided, or is dividing, except the macromeres *A*, *B* and *C*. The "apical" cells have given rise to the "basals" of the arms of the cross; one second quartet cell in each quadrant has produced the "tip" cell (stippled) of each arm; the third quartet cells are dividing læotropically, and the macromere *D* has produced the mesentoblast cell, 4*d*.

Fig. 9.—Fifty-five-cell stage. All divisions initiated in the preceding figure are here completed, and in addition the basal cells of the transverse arms of the cross have divided. The mesentoblast (4*d*) has given rise to six cells (two large and four small ones), and the macromeres *A*, *B* and *C* have given off the other members of the fourth quartet, viz., 4*A*, 4*B* and 4*C*.

Fig. 10.—Fifty-six-cell stage. Similar to the preceding, but showing the basal cell of the anterior arm of the cross divided and spindles in some of the cells derived from the second quartet. The cross is shown in heavy outline; there are three cells in each of the arms except the posterior one. The centre of the cross is here, and elsewhere, marked by a cross line, the "tip" cells of the arms, by stipples.

Fig. 11.—Irregular 81-cell stage; derived from preceding stage by division of the basal cell of the posterior arm, of eight cells of the third quartet, of eight cells of the second quartet, and of eight turret cells.

Fig. 12.—Eighty-five-cell stage; derived from the preceding by the completion of all divisions there indicated and by the subdivision of the basal and middle cells in the transverse arms of the cross.

PLATE XXV.—Blastoderms, showing later stages of cleavage.

Fig. 13.—Another 85-cell stage, consisting of 72 ectomeres, 6 mesentomeres and 7 entomeres.

Fig. 14.—Stage with 111 cells; 98 ectomeres, 6 mesentomeres and 7 entomeres. This is a more advanced stage than the two following ones.

Fig. 15.—Stage with 89 cells; 76 ectomeres, 6 mesentomeres, 7 entomeres.

Fig. 16.—Stage with 104 cells; 91 ectomeres, 6 mesentomeres, and 7 entomeres.

Fig. 17.—Stage with 121 cells; 104 ectomeres, 10(?) mesentomeres and 7 entomeres.

Fig. 18.—Stage of about 320 cells. The ectomeres are very numerous and are somewhat depressed below the general level in the region anterior to the apical pole. The nuclei of the secondary macromeres, 4*A*, 4*B* and 4*C*, are dividing.

PLATE XXVI.—Blastoderms, from the time of formation of the apical invagination to the appearance of the primordia of definitive organs. All nuclei and cell boundaries, where shown, were drawn with the camera lucida, so that their number and location are fairly accurate.

Fig. 19.—Stage of approximately 512 cells. The apical invagination (*A.I.*) is a deep pit just anterior to the animal pole. The mesentoblast (4*d*) has given rise to the mesodermal bands (*Ms.*).

Fig. 20.—Stage slightly more advanced than the preceding, showing the apical invagination as a tubular ingrowth, with its opening near the anterior edge of the blastoderm; the nuclei of the secondary macromeres (4*A*, 4*B* and 4*C*) are dividing a second time.

Fig. 21.—Stage immediately after the flattening out of the apical invagination, only a trace of which is here shown. On each side of the latter is a group of cells, lying beneath the surface of the blastoderm, and represented with solid black nuclei, which are probably "larval mesoderm" cells (*L.M.*); the superficial group of cells in this region ultimately gives rise to the cerebral ganglion (*Cb.*), while the aggregation of cells lying between and in front of the mesodermal bands (*Ms.*) is the primordium of the shell gland. Two of the secondary macromeres (4*A* and 4*C*) have, exceptionally, divided.

Fig. 22.—In this and the following figures all traces of the apical invagination have disappeared; in other respects this figure is similar to the preceding one.

Fig. 23.—Stage of about 1,000 cells, in which the shell gland is plainly visible as a disk of cells, slightly depressed in the middle, and in which the primordia of the cerebral (*Cb.*), buccal (*Bc.*), pleural (*Pl.*), and pedal (*Pd.*) ganglia and of the intestine (*In.*) are recognizable as groups of cells. The row of nuclei on the outer side of each cerebral ganglion probably represents the primordium of the velum, while the more deeply staining area connecting the two cerebral ganglia across the apical pole probably corresponds to the "cephalic neural plate" of annelids. The nuclei of the secondary macromere (4*B*) are dividing a third time, but the cell body remains undivided.

Fig. 24.—Stage in all regards similar to the preceding, except that the blastoderm has grown larger. The nuclei in the macromeres have here reached their maximum size (cf. the nuclei of the same cells in figs. 7 and 10).

PLATE XXVII.—Entire eggs, showing stages from the appearance of organ primordia to the completion of the overgrowth of the yolk.

Figs. 25 and 26.—Stages similar to the one shown in fig. 24. The primordia of different organs are indicated by the closely stippled areas, the stipples representing nuclei.

Fig. 27.—Stage in which the blastoderm has extended through the growth of its anterior portion, over about one-third of the yolk. The organ primordia are confined to a small area in the posterior margin of the blastoderm. The nuclei of the macromeres are dividing.

Fig. 28.—Stage in which the blastoderm has overgrown about one-half of the yolk. Primordia of the following organs are shown: Cerebral ganglia (*Cb.*), velum (*V.*), buccal ganglia (*Bc.*), pleural ganglia (*Pl.*), pedal ganglia (*Pd.*), otocysts (between pleural and pedal ganglia), intestine (*In.*), parietal ganglia (on each side of intestine), and shell gland.

Fig. 29.—Stage in which about two-thirds of the yolk has been overgrown. In addition to the organ primordia already named, the foot is also visible between the two pedal ganglia.

Fig. 30.—Final stages in the overgrowth of the yolk. The blastopore (*Bp.*) is a relatively small area of yolk at the vegetal pole, still uncovered by the blastoderm. The secondary macromeres (4*A*, 4*B* and 4*C*) lie in the lips of the blastopore, and while they contain many nuclei their cell bodies are still undivided. The velum has begun to extend forward around the anterior side of the blastopore, while the buccal ganglia (*Bc.*) lie in its lateral borders. All the organ primordia named above are plainly visible, and in addition the abdominal ganglion may be seen on the left of the intestine.

Plate XXVIII.—Entire embryos, from the closure of the blastopore to the formation of the larva.

Fig. 31.—Embryo showing the blastopore very small. The margin of the shell gland has extended widely, while the area within this margin is covered by the embryonic shell (*Sh.*).

Fig. 32.—Stage showing the closure of the blastopore and the establishment of the pre-oral and post-oral velar bands The margin of the shell gland shows a deep notch posterior to the intestine, which grows more pronounced in later stages. The two cerebral ganglia are approaching each other in front of the blastopore. The primordium of the permanent kidney (*K.*) is recognizable.

Fig. 33.—Older stage, in which nearly one-half of the embryo is covered by the shell. The cerebral ganglia are united by a commissure in front of the mouth.

Fig. 34.—A stage in which about two-thirds of the embryo is covered by the shell.

Fig. 35.—Stage showing head vesicle (*H.V.*), larval heart (*L.H.*), mantle (*M.*), columellar muscle (*Cm.M.*), external kidneys (*Ex.K.*) and tentacles, (*T.*) in addition to the other organ primordia named in the description of figs. 28–30.

Fig. 36.—Later embryo, showing the formation of the mantle cavity, gill, velar lobes and the twisting of the nerve loop. The primordia of all important organs are present at this stage.

NOTES ON SOME PACIFIC CIRRIPEDES.

BY HENRY A. PILSBRY.

The following notes on Japanese and Northwestern Pacific species of *Scalpellum*[1] are based upon material collected by the U. S. Fish Commission Str. *Albatross* in 1906, and are preliminary to an illustrated report to be published later. A new *Balanus*, the second to be made known of a peculiar group of forms living imbedded in sponges, is described from material presented to the Academy by Mr. C. R. Orcutt.

Of the "imperfectly calcified" species of *Scalpellum*, several are now known from Japanese waters, belonging to two slightly different groups, the group of *S. intermedium* and that of *S. japonicum*.

In the group of *S. intermedium* the small inframedian latus is narrowly triangular, widest at the base, with the umbo above and apical; the upper latus may be either triangular, biramose, or notched basally. Here belong the Japanese *S. nipponense* Pils., and from southern waters, *S. intermedium* Hoek and *S. laccadivicum* Annandale. All of these are very closely related, and may even prove to be varieties of a single species when fuller series of the growth stages come to light.

In the group of *S. japonicum* Hoek, the inframedian latus is broad above, narrow at the base, with the umbo basal or near the base. Some very interesting forms of *S. japonicum* were taken by the *Albatross* at Stations 4,972 and 4,967, off the east coast of Nippon. They show wide variation in the shape of the calcified portions of the upper and carinal latera. Two individuals from Station 4,972 diverge so widely from the type of *S. japonicum* that a subspecific name may be useful.

Scalpellum japonicum metapleurum n. subsp.

Differs from *S. japonicum* chiefly by the shape of the upper latus, which is calcified only in a band parallel to its tergal border.

Scalpellum gonionotum n. sp.

A species closely resembling *Scalpellum balanoides* Hoek, but larger, and differing by the *angular dorsal outline* of the capitulum and the shape of the carina, which is straight, with very narrow sides and a flat roof. There is a linear rostrum, not reaching to the base, or covered there by the rostral latera. The peduncle is closely covered with imbricating scales.

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[1] Published by permission of the Commissioner of Fisheries.

Length of capitulum 7, breadth 3.6 mm.

Albatross Station 4,901.

Scalpellum weltnerianum n. sp.

A species with fourteen loosely juxtaposed valves, regularly arched carina with apical umbo, rounded roof, in section like the letter U, and straight occludent border. There are very sparsely scattered hairs 2 to 3 mm. long, chiefly near the occludent margin. The paired plates have a sculpture of close radial riblets. Tergum erect and acute. Upper latus about twice as high as wide. Rostrum rather large, lozenge-shaped, with a median rib. Rostral latus quadrangular, as high as wide. Inframedian latus rather narrow, triangular, with acute apical umbo. Carinal latus with convex carinal and concave upper margins, the umbo apical, incurved. The carina extends in a narrow triangle between the carinal latera to the peduncle. Peduncle clothed with projecting scales curved in at their apices, arranged in six rows of about fifteen scales each.

Length of capitulum 11.5, breadth 5 mm.; length of peduncle about 5 mm.

Albatross Station 4,918, off Kyushu, in 361 fathoms, on a crinoid pinnule. August 13, 1906.

A very distinct species, shaped like *S. album*, but strongly sculptured.

Balanus orcutti n. sp. Plate XXIX, figs. 1–7.

A species closely related to *B. declivis* Darwin, living wholly imbedded in sponges.

Walls conical, with a small oval orifice and concave membranous base. The carina is double the length of the other plates, strongly arcuate, its projecting lower end tongue-shaped. The rostrum is slightly longer than the lateral plates. The radii and alæ are well sunken and smooth; the parietes marked with growth-lines and deep fine wrinkles, oblique to the growth-lines, and in places broken into long granules. The sheath is closely sculptured transversely with low ridges and covered with yellowish cuticle densely ciliated along the ridges. Below the sheath the plates are vertically ridged, especially the carina.

The scutum is triangular, densely sculptured with thread-like lamellæ parallel to the basal margin. The articular ridge is about half the length of the plate, wide and triangular. The adductor ridge is distinct but low. The cavities of the adductor and depressor muscles are deep.

The tergum is wide and triangular, the scutal and carinal margins straight. It is sculptured externally like the scutum; without a distinct spur, which is represented only by a slight wave in the basal margin. Internally there is a very short articular ridge and furrow; elsewhere the surface is irregularly roughened with short rugæ and some longitudinal wrinkles converging to the apex.

Height of the wall (to base of carina) 18 mm.; length of base 11, breadth 9.2 mm.

San Ysidro, Lower California. Type No. 1,783, A. N. S. P., collected and presented by C. R. Orcutt, 1889. There are also specimens from the same place and collector in coll. U. S. National Museum.

The barnacles live wholly imbedded in sponges and can be found only by breaking them up. *Balanus orcutti* differs from *B. declivis* Darwin[2] of the West Indies, by the peculiar sculpture of the external surface, which is obliquely corrugated or tuberculate in places, and by the shapes of the opercular valves. In *B. declivis* the scutum is wider, its greatest breadth contained twice in the length, while in *B. orcutti* the breadth is contained fully two and one-half times in the length. The tergum, on the other hand, is wider in *B. orcutti*, with a much less developed "spur," and a less wide inflected scutal area is seen in the interior view than Darwin figures for *B. declivis*. These characters show no noticeable variation in the series examined.

The specimens are dry, and the cirri and other internal parts have been destroyed.

Explanation of Plate XXIX.

Fig. 1.—*Balanus orcutti*, carinal view of the wall.
Fig. 2.—Lateral view of the wall.
Fig. 3.—Rostral view of the wall.
Figs. 4, 5.—Interior and external views of the scutum.
Figs. 6, 7.—Interior and external views of the tergum.

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[2] *Monograph on the Cirripedia, Balanidæ*, p. 275. *B. declivis* has also been reported from Batjan, Moluccas, by Weltner, *Verz. recenten Cirripedenarten*, p. 270.

ON THE SYNONYMIC HISTORY OF THE GENERA CLAVA MARTYN, AND CERITHIUM BRUGUIÈRE.

BY WILLIAM HEALEY DALL.

The synonymic history of these genera is quite complicated, especially if one takes into consideration the minor subdivisions.

Most writers have hesitated to undertake revision of the Cerithiacea on account of the difficulties involved. During recent years the subject has been recalled to attention by the elucidation of the true dates of the volumes of Martyn's *Universal Conchologist* and by the publication of Part VII of M. Cossmann's *Essais de Paléoconchologie Comparée,* which included a review of the Cerithiacea.

The conclusions in regard to the validity of certain generic names established by Martyn, which resulted from my determination as to their correct date, has been dissented from by M. Cossmann in his *Essai,* and he supports his arguments by statements of fact which, if uncontroverted, would establish his case.

The difference is, in the main, caused by a different viewpoint as to the reformation of nomenclature, his arguments for which are supported by inaccurate citations.

In 1830 systematists considered it entirely proper to "ignore" little known names; to alter names which did not suit the Latinity or the taste of the person writing; to neglect more or less completely the early history of names; and to cite prelinnean and polynomial writers for systematic synonymy. These ideas, as we all know, were but slowly modified, since they appealed to the common preference for what is familiar, as well as to the indolence and carelessness of the hasty or amateur writer. As all know who have had occasion to use his very useful summaries, M. Cossmann has not, so far, entirely freed himself from these prepossessions, and has even on more than one occasion intimated that the acceptance of one or the other name of two in conflict should depend on the eminence of the author originating the name, rather than on the priority of publication; while his indignation at the resurrection of "obscure" names seems both sincere and profound.

One cannot but feel some sympathy with the regret that familiar (if erroneous) names must be eliminated from general use.

For some years I urged the maintenance of the first British Association rules, which required a diagnosis to validate a new genus or subgenus. But these views not being acceptable to the majority of zoologists, and the International Congresses having formulated a series of working rules in which this principle was not enforced, and believing that a stable nomenclature can only result from the general, impartial, rigidly exact enforcement of the rules adopted, I have proceeded in my work on that basis.

That it has resulted in necessary changes was the fault of the illogical and inaccurate methods of the early part of the nineteenth century, which M. Cossmann and those who sympathize with him seem to desire to perpetuate.

One cannot argue on such a question unless from a common standpoint, which being wanting, I have left unanswered numerous criticisms of my work by M. Cossmann, recognizing his right to his own standpoint and the futility of argument under the circumstances.

But if one admits perfect freedom in selection of principles, one does not necessarily waive the right to have the facts in the case accurately stated by the critics. In this direction M. Cossmann's writings leave much to be desired. Lest I should be supposed to acquiesce in them, I have thought it best to select a concrete case, that of M. Cossmann's treatment of the history of Martyn's genus *Clava*, afterwards named *Cerithium* by Bruguière, which M. Cossmann has had occasion to notice in his account of the Cerithiacea in the publication alluded to.

In order to clear up the subject it is necessary to enter into the history of the genus *Cerithium*. This name was first applied by Fabio Colonna in his treatise *De aquatilibus*[1] to a shell afterwards named *Cerithium adansonii* by Bruguière. The name was adopted by Adanson for a group containing Cerites and Turritellas,[2] one of which, *Le Cerite* (p. 155), he identified with Colonna's shell. These authors were prelinnean and, except historically, not entitled to be cited in synonymy.

In 1792 Bruguière adopted the name and for the first time introduced it into binomial nomenclature,[3] naming no type, but dividing the genus into three unnamed groups, the first of which corresponds to *Vertagus* Klein, the first species being *C. obeliscus* Bruguière.

In 1799 Lamarck published his *Prodrome*,[4] in which he cited as type *Murex aluco* Linné. Two years later, however, in his *Système*,[5] he mentions as example *C. nodulosum* Bruguière, which was by the latter, as by Adanson, supposed to be Colonna's original species. Roissy[6] adopted the genus in Bruguière's sense; his first species was a *Vertagus* (Klein). In 1807 Link[7] followed Lamarck's *Prodrome* and put under *Cerithium* (Lam.) his species resembling *Vertagus* (Klein), beginning with *C. aluco*, which type was not then discriminated from the others, and gave to Bruguière's second group of true Cerites the name *Aluco* with *Cerithium adansonii* Bruguière as his first species. Montfort in 1810[8] had also followed the lead of Lamarck in 1799 and figured *Murex vertagus* as the type of *Cerithium* s. s. after eliminating *Telescopium* and *Pyrazus* (=*herculea* Martyn). Schumacher[9] in 1817 has three groups under *Cerithium*, corresponding to *Pyrazus* Montfort (*C. palustre* Lam.), *Cerithium* Lamarck, 1801 (*C. nodulosum* Brug.), and *Cerithium* Lamarck, 1799 (*C. aluco* Linné). He also adopts Klein's name *Vertagus* with two groups, the first typified by *Murex vertagus* Linné, and the second by *Murex asper* Linné, which differs only by rougher sculpture.

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[1] *De aquatilibus aliisque nonullis animalibus*, Roma, 1616, pp. 53, 57.

[2] *Sénégal*, pp. 152–160, 1757.

[3] *Encycl. Meth.*, I, pt. 2, 1792, p. 467. Not issued in 1789, as stated by Cossmann and various other authors.

[4] *Prodr. nouv. class.*, p. 73, 1799.

[5] *Syst. des an. s. vert.*, p. 85, 1801.

In referring to species I have corrected the synonymy, which is often complicated, but refrain from inserting the details here.

To return to the parallel nomenclature, in 1753 Klein, who was one of the worst of the polynomialists, proposed the name *Vertagus*, his first "species" being *Murex vertagus* Linné. This name of course had no standing. Link in 1807[10] used *Vertagus* for a totally different group containing species of *Terebra*, and Schumacher's return[11] to Klein's type was necessarily too late to remedy matters.

Martyn's name *Clava* was first published[12] not later than 1784, as elsewhere proved beyond any doubt. The four species published in that year may be identified as follows:

1. *Clava rugata* Martyn = *Murex asper* Linné.
2. *Clava herculea* Martyn = *Cerithium ebeninum* Brug.
3. *Clava maculata* Martyn = *Cerithium clava* Brug.
4. *Clava rubus* Martyn = *Cerithium echinatum* Lam.

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[6] *Hist. nat. Moll.*, VI, p. 106, 1805.
[7] *Beschr. Rostock Samml.*, p. 130, 1807.
[8] *Conch. Syst.*, II, p. 511, 1810.
[9] *Essai*, pp. 223–4 and 227–8, 1817.
[10] *Beschr. Rostock Samml.*, p. 128, 1807.
[11] *Essai*, p. 227, 1817.
[12] *Universal Conchologist*, I, table, Nos. 12, 13. In the second series of forty plates, sometimes called by Martyn Vol. II, figs. 57 and 58 represent respectively *Clava maculata* and *C. rubus* Martyn. The species in Vol. III date only from 1786 and need not be considered in selecting a type, though of interest as showing that Martyn's conception of his genus *Clava* was practically the same as Bruguière's conception of his genus *Cerithium*, eight years later.

These are referable to the following groups:

3. *Cerithium* Lamarck, 1799; type *C. aluco* L. (+*Pseudovertagus* Vignal, 1904).
4. *Cerithium* Lamarck, 1801; type *C. nodulosum* Brug. (=*Aluco* Link, 1807).
2. *Pyrazus* Montfort, 1810; type *C. ebeninum* Brug.
1. *Vertagus* (Klein) Schumacher, 1817 (not of Link, 1807) = *Clava* Martyn, 1784+*Rhinoclavis* Swainson, 1840.

It thus appears that, whether we adopt the "first species" rule or the method of "elimination," Martyn's first species becomes his type. *Pseudovertagus* (*aluco*) is, in my opinion, generically distinct from *Clava* and much more nearly related to the true Cerites of Adanson and Lamarck (1801). This conclusion is essentially the same as that reached by Pilsbry.[13]

The date of Gmelin's volume is of general interest to those working in systematic Malacology, so that I have given the details; but for our present purpose it is sufficient to say that Martyn's work (the first 80 plates) is cited throughout Gmelin's volume, and some of his specific names are adopted by Gmelin.[14] This conclusively shows that, whatever the date of either work, Martyn precedes Gmelin, and *Clava* Gmelin, *non* Martyn, becomes a synonym.

M. Cossmann further suggests that a genus *Clavus* precedes and reduces *Clava* Martyn to synonymy. But in this case he has obviously forgotten the fact, patent in any Latin lexicon, that *Clava*, a club, is a feminine substantive not identical with the masculine *Clavus*, a nail. The two are as distinct as *Pica* and *Picus*.

In 1884[15] Jousseaume proposed to apply the name *Clava* to the group represented by Martyn's *Clava tessellata*, a species which is No. 97 in his third volume. This course is inadmissible, because *tessellata* is not one of the original species of 1784, but at earliest dates from 1786.

The name *Clava* in Martyn's sense appeared subsequently among the early writers only once. In the anonymous Museum Calonnianum it is used, practically as Martyn used it, for the whole group of *Cerithium* in the Lamarckian sense. But, as I have hitherto maintained that a work with no ostensible author or publisher is not entitled to be cited as valid in systematic synonymy, I do not consider that this incident adds any strength to the case for the adoption of *Clava* Martyn as a systematic name.

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[13] *Proc. Acad. Nat. Sci. Phila.* for 1901, p. 392.

[14] Such as *Buccinum scutulatum* (Martyn) Gmelin, and *Patella calyptra* (Martyn) Gmelin. See also pp. 3483, 3490, 3498, 3690, 3691, 3697, 3702, and 3712 (and many others) for citations by Gmelin of Martyn's figures.

[15] *Bull. Soc. Zool. de France*, IX, p. 23, 1884.

Gmelin's use of the word *Clava* in a generic sense for a Cœlenterate animal, though cited by Cossmann as of 1789, is really not earlier than 1791, and until very recently has been regarded as of 1792.[16]

On the twenty-sixth page of part VI of Gmelin's work (p. 3056, No. 19) there is a reference to a paper of Braun, published in the tenth volume of the *Schriften der Gesellschaft Naturforschende Freunde zu Berlin*, page 58. This paper has been stated to have been issued in 1792, and if so the volume in which it is cited cannot be of earlier date.[17]

Lately M. Vignal, who has made a specialty of the Cerithiidæ, proposed the name[18] *Pseudovertagus* for forms allied to *C. aluco* Linné, which have an external appearance more or less like those of the type of *Murex vertagus* Linné, but want the strong spiral plication on the pillar. After examining the specimens in the Museum, I am of the opinion that this separation is absolutely justified. The fossil forms in Europe, according to M. Cossmann, are of this latter type, and so are most of the American species; but we have at least one species in the Chipola Oligocene which is unmistakably of the type of *C. vertagus*, so far as the plicate axis is concerned. There is also a recent species resembling *C. kochii* Philippi, at Barbados. The absence of the Indo-Pacific type from the European Tertiaries may therefore be due to its absence from that region faunally, and not to any ancestral character of the *Pseudovertagus*.

We are now in a position to review the facts above cited.

We may judge from the aggregate of the data that, disregarding prelinnean polynomialists, the first binomial author to recognize the group commonly called *Cerithium* in nomenclature was Martyn, who named it *Clava*, having two species in his first publication, of which the first was a "*Vertagus*" and the second a *Pyrazus*.

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[16] Gmelin's Vol. VI of his edition of the *Systema Naturæ* bears no date on the title.

[17] The paper referred to is M. Braun, Beitr. zur Gesch. d. Eingeweider-würmer. See Carus and Englemann, *Bibl. Zool.*, I, p. 362, where the date of Braun's paper is given as 1792. Also H. C. Bolton, *Cat. Sci. Periodicals*, second edition, p. 1023, where the date of Vol. X, above referred to, is given as 1792.

It is possible that Braun's paper was issued earlier in separate form, but in that case we should not expect that Gmelin would cite the page of the completed volume, instead of the page of the separate issue. Possibly some part of Vol. X may have appeared earlier than the date of the completed volume. Ant. Collin discusses the question in the *Zool. Anzeiger* for January, 1899, pp. 4, 5, and comes to the conclusion that at least a portion of Gmelin's part VI appeared between August 21, 1790, and May 14, 1791, probably in one of the early months of 1791. I have for some time followed Carus and Englemann and Bolton in using the date 1792 for this volume of Gmelin, instead of 1790 as used by Sherborn in the *Index Animalium* (p. 221), since the latter does not give detailed data in his preliminary bibliography; but after Collin's discussion, called to my attention by Dr. Stiles recently, it seems reasonable to compromise on 1791 as the most probable date.

[18] *Bull. Mus. Hist. Nat. Paris*, X, p. 358, 1904.

The next author was Bruguière, who habilitated *Cerithium* Adanson, without mentioning a type and with limits, as M. Cossmann expresses it, which "ne répond à rien de bien précis." Lamarck's first effort to select a type fell on a species of *Pseudovertagus*.

In this[19] he was followed by Link (1807), Montfort (1810) and Cuvier (1817). Lamarck's second effort reverted to the antique type represented by *C. nodulosum*.

In this he was followed by Schumacher (1817), who included the *aluco* group under *Cerithium* (Lam.) proper, and separated the *Clava* group with plicate axis under the untenable name of *Vertagus*. Most modern authors have, in a general way, followed Schumacher.

Bruguière, Lamarck and Deshayes were familiar with Martyn's work, referred to it with high praise, and cited his names in synonymy; the loose practice of changing specific names to suit the fancy of the author, without reference to priority, being still in vogue.

M. Cossmann's criticisms have been made with such an air of confidence and so much particularity of detail, that the incautious reader might well suppose they were founded upon an accurate determination of the facts. Yet in the present case it has been shown that of three dates essential to a right decision, those of Martyn, Bruguière and Gmelin, as printed by M. Cossmann,[20] each and every one is wrong. Only because they are incorrect is he able to arrive at a decision different from mine, first published in 1892[21] and elaborated by Pilsbry in 1901.[22] Since an analysis of my previous paper on Martyn appeared in M. Cossmann's *Revue de Paléozoologie*, shortly after its publication, it seems difficult to account for the presence of the false date 1789 for Martyn's first volume in the last number of the *Essais*, and one would expect, after Sherborn and Woodward's elucidation of the dates of the several parts,[23] that a French author of M. Cossmann's standing would have informed himself of the dates of publication of the *Encyclopédie Méthodique* when they bore directly upon the subject he was discussing.

Whatever view may be taken of Martyn's work, nothing can prevent the recognition of Lamarck's type of 1799 as the type of the genus *Cerithium*, provided one accepts the international code of rules governing zoological nomenclature.[24] The rejection of *Clava* Martyn would not alter this fact. But, in any case, this system of nomenclature of the *Cerithiidæ*, laboriously built up by M. Cossmann on an insufficient knowledge of the nomenclatorial history of the family, must submit to profound modifications before it can be approved by those who accept the international rules.

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[19] *Vertagus* and *Pseudovertagus* being at that time not differentiated.

[20] *Essais de Paléoconch. Comp.*, VII, pp. 65, 84, 1907.

[21] *Trans. Wagner Inst.*, III, part II, p. 290, 1892.

[22] *Proc. Acad. Nat. Sci. Phila.* for 1901, p. 392.

[23] *Proc. Zool. Soc. London*, 1893, pp. 582–584.

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[24] *Règles internationales de la nomenclature Zoologique adoptées par les Congrès Internationales de zoologie.* Paris. Rudeval, 1905, 8°. p. 57.

ORTHOPTERA OF THE FAMILIES TETTIGONIDÆ AND GRYLLIDÆ FROM SAPUCAY, PARAGUAY.

BY JAMES A. G. REHN.

This paper completes the study of the Sapucay collection of Orthoptera made by William T. Foster and now the property of Mr. Morgan Hebard. Five of the families of the order were treated in a recent paper in these *Proceedings*,[1] to which the reader is referred for the titles of previous papers on Sapucay Orthoptera. The asterisk is used here, as in the previous paper, to designate species not previously recorded from Sapucay.

In previous papers forty-one species of the two families here treated were recorded from Sapucay; thirty-six are here recorded, but of this number six are new species and twelve previously known species are recorded from the locality for the first time.

The author wishes to thank Mr. Hebard for the privilege of studying this valuable collection.

TETTIGONIDÆ.

PHANEROPTERINÆ.

ISOPHYA Brunner.

1878. *Isophya* Brunner, Monogr. der Phaneropt., pp. 13, 59.

Type.—*I. brasiliensis* Brunner.

Isophya borellii Giglio-Tos.

1894. *I[sophya] Borellii* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 37. [Province of San Pedro and Asuncion, Paraguay; Santa Rosa, Salta, Argentina.]

March, 1905; two males, ten females.

These individuals are clearly referable to *borellii*, the males having the cercal tooth distinctly before the apex, the females having but the apical third of the dorsal margin of the ovipositor crenulate.

Isophya hamata Giglio-Tos.

1894. *I[sophya] hamata* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 37. [Province of San Pedro, Asuncion and Colonia Risso on the Rio Apa, Paraguay.]

August, 1901; one male.

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[1] *Proc. Acad. Nat. Sci. Phila.*, 1907, pp. 151–192.

The apical cercal tooth and the more transverse plicate vein readily distinguish the males of this species from those of *borellii*. The range of this species is from Corumbá, Matto Grosso, Brazil, south to Sapucay.

HYPEROPHORA Brunner.

1878. *Hyperophora* Brunner, Monogr. der Phaneropt., pp. 16, 125.

Type.—*H. brasiliensis* Brunner.

Hyperophora brasiliensis Brunner.

1878. *H[yperophora] Brasiliensis* Brunner, Monogr. der Phaneropt., p. 126. [Brazil.]

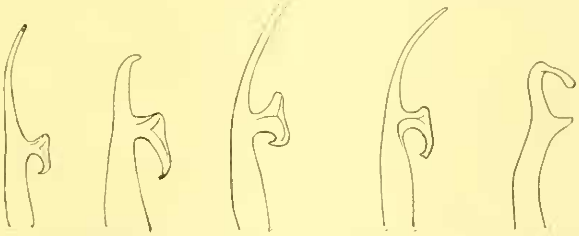
December, 1904, March, 1905; three males, two females.

There is considerable variation in these individuals in the depth of the coloration of the tegmina: in several specimens the green being very much richer and deeper than in the others. The male cercus of this species is represented by fig. 1.

This species ranges from Brazil to Buenos Ayres, Argentina.

***Hyperophora cerviformis** n. sp.

Type: ♂; Sapucay, Paraguay. February 27, 1905. (William Foster.) [Hebard Collection.]



Figs. 1–5.—Male cercus of species of *Hyperophora* (viewed from the dorsum). 1. *H. brasiliensis* Brunner. 2. *H. cerviformis* n. sp. 3. *H. major* Brunner. 4. *H. gracilis* n. sp. 5. *H. minor* Brunner. (× 8.)

Allied to *H. brasiliensis*, but differing in the slenderer form, the more elongate tegmina and the shorter cerci, which are moderately recurved distad, and with the proximal portion of the median process elongate and spined.

Size medium; form distinctly elongate, slender, compressed. Head short and deep, very considerably broader than the pronotum; occiput rounded; vertex moderately declivent, fastigium narrow, compressed, low, margins elevated, depressed mesad, at the extreme apex not touching the frontal fastigium which is trigonal; eyes ovate, prominent; antennæ rather thick, fragile, not perfect in the type, proximal joint about as broad as the eye. Pronotum with the disk subdeplanate, slightly sellate; lateral margins subparallel, acute, the width of the disk contained about once and a half in the length, cephalic margin moderately concave, caudal margin moderately arcuate, a distinct rectangulate impressed line mesad; lateral lobes distinctly longitudinal, the greatest depth, which is caudad, contained once and a half in the length, cephalic margin slightly sinuate oblique, ventral margin slightly emarginate over the coxæ and very slightly angulate caudad of this, caudal margin with a distinct rectangulate humeral sinus, otherwise rounded. Tegmina reaching about to the tips of the caudal femora, narrow, lanceolate, the greatest width contained about six and a half times in the length, costal field well rounded proximad, otherwise the margins taper almost imperceptibly to the rounded apex; discoidal vein with three rami which are connected by diagonal supplementary veins; anterior ulnar vein fusing slightly distad of the apical third and with two principal rami; tympanum distinctly longer than broad. Wings with apex acute, exceeding the tegmina by a length equal to that of the head and pronotum together. Terminal dorsal abdominal segment produced mesad into a subtrigonal process which is somewhat bullate; cerci, produced moderately tapering, apex blunt, somewhat depressed, narrowly recurved dorso-mesad, median process strongly produced in a proximal direction parallel with the shaft, acute, no development distad; subgenital plate with a rotundato-angulate emargination, lateral apical angles rather blunt, ventral surface with three subparallel carinæ. Cephalic femora but slightly shorter than the head and pronotum together; median femora twice as long as the pronotum. Caudal femora once and one-third the

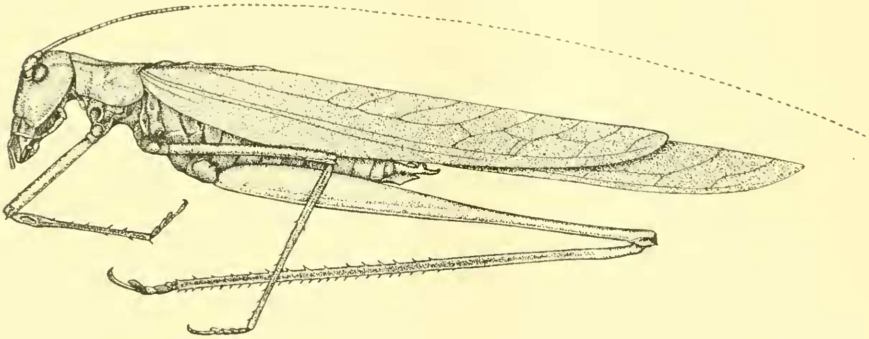


Fig. 6.—*Hyperophora cerviformis* n. sp. Lateral view of male type. (× 2½.)

length of the body, slender; caudal tibiæ slightly longer than the femora.

General color apple green turning to olive-yellow and naples yellow on the head, pronotum and limbs. Eyes prouts' brown, a weak narrow postocular line and the more distinct continuation of the same on the angle of the pronotum liver brown, the tympanum very broadly margined laterad with the same; tibiæ oil green, the caudal becoming olive-green distad.

Measurements.

Length of body,	17 mm.
Length of pronotum,	4 "
Length of tegmen,	27.5 "
Length of caudal femur,	22.7 "

The type is the only specimen seen by the author.

Hyperophora major Brunner.

1878. *H[yperophora] major* Brunner, Monogr. der Phaneropt., p. 126, tab. II, fig. 24. [Buenos Ayres, Argentina.]

March and May, 1902; two males, two females.

These specimens are slightly smaller than the measurements given for this form by Brunner, but as far as can be determined from his brief description they represent this species. The measurements of a Sapucay male and female are as follows:

	♂	♀
Length of body (exclusive of ovipositor),	20 mm.	22.5 mm.
Length of pronotum,	4.6 "	4.6 "
Length of tegmen,	29.5 "	30.5 "
Length of wing beyond tegmen,	6.5 "	6.1 "
Length of caudal femur,	24 "	24.5 "
Length of ovipositor (apex to ventral base),		5.5 "

The male cercus of this species is represented in fig. 3. This species has been recorded from Buenos Ayres and Santa Rosa, Salta, Argentina, and Urucum, Matto Grosso, Brazil.

***Hyperophora gracilis** n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. February 27 (♀) and March 7 (♂), 1905. (William Foster.) [Hebard Collection.]

In a way this species connects certain previously known species of the genus, but in the form of the ovipositor it appears to be close to *H. angustipennis* Brunner, while the strongly lamellato-carinate ninth dorsal abdominal segment of the male is apparently peculiar to the new species. In possessing lateral lobes of the pronotum of equal depth and in having the mediastine vein by no means as well marked as in the *major-peruviana* group it occupies a rather intermediate position.

Size medium; form elongate, slender, somewhat compressed. Head distinctly broader than the pronotum, the occiput rounded, vertex declivent, fastigium narrow, longitudinally sulcate, apex blunt and in contact with the blunt apex of the facial fastigium; eyes subovate, strongly exserted; antennæ elongate, proximal joint as broad as the eye. Pronotum with the dorsum deplanate, slightly sellate; lateral margins subparallel, angulate, subcarinate, the breadth of the disk contained about once and a half in the length, cephalic margin very slightly emarginate, caudal margin arcuate, a distinct but low median carina present on the extreme caudal section of the disk, cephalad of this there is an indication of the same but no carina, rectangulate impressed pattern slightly caudad of the middle; lateral lobes with the greatest depth contained nearly twice in the length, caudal margin subsinuate with a faint trace of a supra-coxal emargination, humeral sinus distinct, rectangulate, the remainder of the caudal margin slightly arcuate and the ventro-caudal angle rather narrowly rounded. Tegmina exceeding the length of the body by about that of the pronotum, the greatest width contained about seven times in the length, margins approximating little, except in the apical fifth where the costal margin arches distinctly to the narrowly rounded apex; discoidal vein with four rami, all of which are distinctly sublongitudinal in their middle course, diagonal in the remainder; anterior ulnar vein with no distinct rami in the male, one to two in the female, the vein itself being connected by a short vein with the proximal rami of the discoidal vein. Wings exceeding the tegmina by nearly twice the length of the pronotum, the apex tapering and acute. Terminal dorsal abdominal segment of the male with a short acute process over the base of each cercus and a

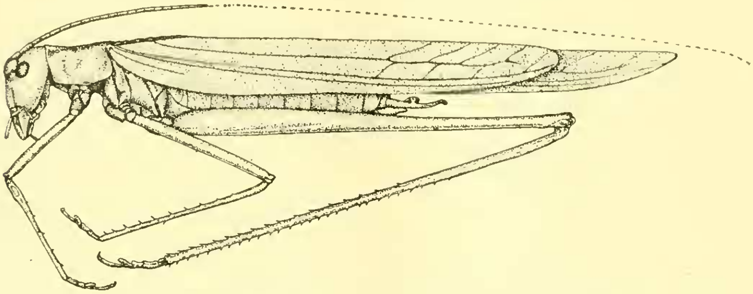


Fig. 7.—*Hyperophora gracilis* n. sp. Lateral view of male type. (× 2½.)

larger median trigonal process bearing a high rounded lamellate ridge; cerci elongate (see fig. 4), moderately robust in the proximal section, slender in the distal section which is strongly curved mesad with the apex blunt and somewhat recurved, median process on the distal side of its internal face with only a minute spine, the proximal side with a slender recurved appendage with a slightly expanded emarginato-truncate apex; subgenital plate moderately produced, apex rectangulate emarginate. Ovipositor of the female about half the length of the tegmina, slightly but regularly curved, rather broad, tapering very slightly except toward the immediate apex, dorsal margin slightly and ventral margin distinctly crenulate in the distal third; subgenital plate of the femora very slightly produced with a narrow median emargination. Cephalic femora as long as the pronotum and half of the head; median femora about a third the length of the tegmina. Caudal femora very slender, reaching to the apex of the tegmina.

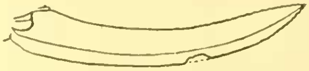


Fig. 8.—*Hyperophora gracilis* n. sp. Lateral view of ovipositor. (× 3.)

General color apple green becoming greenish yellow on the proximal portion of the tegmina, pronotum and head; postocular line and angles of the pronotum brick red, the male tympanum marked laterad not very strongly with the same color; eyes chestnut; caudal tibiæ becoming purplish brown distad.

Measurements.

	♂	♀
Length of body,	21 mm.	—[2] mm.
Length of pronotum,	3.7 “	—[2] “
Length of tegmen,	23.8 “	25.5 “
Length of caudal femur,	21 “	22 “
Length of ovipositor,		11.5 “

Three paratypic males, taken in February and March, 1905, have also been examined. These specimens fully agree with the type in all essential characters. From these specimens it is seen that the male in some cases possesses at least a single ramus to the anterior ulnar vein of the tegmen.

Hyperophora minor Brunner.

1891. *Hyperophora minor* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 59. [Paraguay; Cordoba, Argentina.]

February and March, 1905; fourteen males, thirteen females.

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[2] The head and cephalic portion of the pronotum is missing in the female type.

The cercus of the male of this species is represented by fig. 5. There is an appreciable amount of variation in size in this species, the extremes of the present series measuring as follows:

	♂		♀	
Length of tegmen, . .	24 mm.	25.5 mm.	23.8 mm.	27 mm.
Length of caudal femur,	21.2 "	23 "	22 "	23.6 "
Length of ovipositor,			7.2 "	7.8 "

LIGOCATINUS Rehn.

1878. *Amaura* Brunner, Monogr. der Phaneropt., pp. 25, 247. (Not of Moller, 1842.)
1901. *Ligocatinus* Rehn, Canad. Entom., XXXIII, p. 272.

Type.—*Amaura spinata* Brunner.

Ligocatinus olivaceus (Brunner).

1891. *Amaura olivacea* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien XLI, p. 123. [Rio Grande do Sul, Brazil.]

February, 1903 and 1905; three females.

Terminal spines are present on the external dorsal margin of the cephalic tibiæ in all three specimens.[3]

HOMOTOICHA Brunner.

1891. *Homotoicha* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, pp. 17, 124.

Type.—*H. minor* (Brunner).

Homotoicha fuscopunctata Caudell.

1906. *Homotoicha fuscopunctata* Caudell, Proc. U. S. Nat. Mus., XXX, p. 236. [Sapucay, Paraguay.]

March, 1905; one male.

This specimen has been examined by Caudell, who states there is no doubt in his mind but that it represents the male of his species. As the appendages are undescribed a few notes may be of interest.

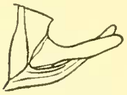

Fig. 9.—*Homotoicha fuscopunctata* Caudell. Lateral view of apex of male abdomen. (× 5.)

Terminal dorsal abdominal segment with the apical margin broadly subtruncate. Cerci with the proximal third very stout, scabrous and bearing on the internal margin a lamellate ridge developed into a falciform process, curving dorsad, the base broad, apex acute and normally touching the base of the opposite cercus; median third of the cercus compressed; apex thickened, obliquely truncate and with a small spine placed in the middle of the truncation, beyond the proximal third the cerci are curved inward.

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[3] *Vide* Caudell, *Proc. U. S. Nat. Mus.*, XXX, p. 236.

Subgenital plate produced, tapering, bent considerably dorsad near the base, deeply and narrowly divided, short styles present.

CERAIA Brunner.

1891. *Ceraia* Brunner, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, pp. 18, 127.

Type.—*C. tibialis* Brunner.

Ceraia cornutoides Caudell.

1906. *Ceraia cornutoides* Caudell, Proc. U. S. Nat. Mus., XXX, p. 237. [Sapucay, Paraguay.]

January, 1903, March, 1905; two females.

SCAPHURA Kirby.

1825. *Scaphura* Kirby, Zool. Journ., I, p. 432.

Type.—*S. vigorsii* Kirby.

Scaphura nigra (Thunberg).

1824. *Gr*[*yllus*] *niger* Thunberg, Mém. l'Acad. Imp. des Sciences, St. Pétérsb., IX, p. 415. [Brazil.]

January and March, 1903 and 1905; one male, three females.

These specimens do not fully agree with any of the numerous color forms of this species, being closer to *vigorsii* Kirby and *chalybea* Marschall than to the others. From the former they differ in the absence of pale markings on the median femora and in the more brownish wings, these latter being distinctly red-brown with a preapical portion infuscate. From *chalybea* they differ in the chalybeous proximal portion of the antennæ comprising eight to thirteen joints, instead of only reaching the third. However they are closer to *chalybea* than to the type called *vigorsii* by Kirby.

I have provisionally considered all the nominal species as forms of *nigra*, which is the oldest name, the probability being that the various forms are geographic and restricted to definite areas. The variation noted in the four specimens in hand is slight, and from this one may infer that variation in one locality is generally no greater.

The resemblance of this species to a Sphegid wasp is very striking, as has already been noticed by Westwood, the similarity to species of the genus *Pepsis* being particularly true of the specimens examined.

GRAMMADERA Brunner.

1878. *Grammadera* Brunner, Monogr. der Phaneropt., pp. 27, 297.

Type.—*G. clara* Brunner.

***Grammadera albida** Brunner.

1878. *G*[*rammadera*] *albida* Brunner, Monogr. der Phaneropt., p. 298. [Brazil.]

November and December, 1904; two males, one female.

As the ovipositor was mutilated in the female type, I have described the appendages of the available female.

Ventral length of the ovipositor two and one-half times that of the disk of the pronotum, slightly falcate, greatest width immediately distad of the middle and contained about four times in the length, apex acute, both margins crenulate for about a third their length. Subgenital plate small, apex broadly emarginate.

***Grammadera rostrata** n. sp.

Type: ♀; Sapucay, Paraguay. February 10, 1905. (William Foster.) [Hebard Collection.]

Allied to *G. clara* and *albida*, differing from the former in the more arcuate ovipositor, the less quadrate lateral lobes of the pronotum and the slenderer limbs. From *G. albida* it differs in the smaller eyes, the more produced and subequal fastigium, the more distinctly disto-median insertion of the median vein and the less quadrate lateral lobes of the pronotum. From *G. hastata* Brunner and *pellucida* and *rosea* Giglio-Tos it is separated by a number of characters, the chief of which is the sulcate fastigium (not sulcate in *hastata*) and the emarginate subgenital plate (entire or rotundate in *pellucida* and *rosea*).

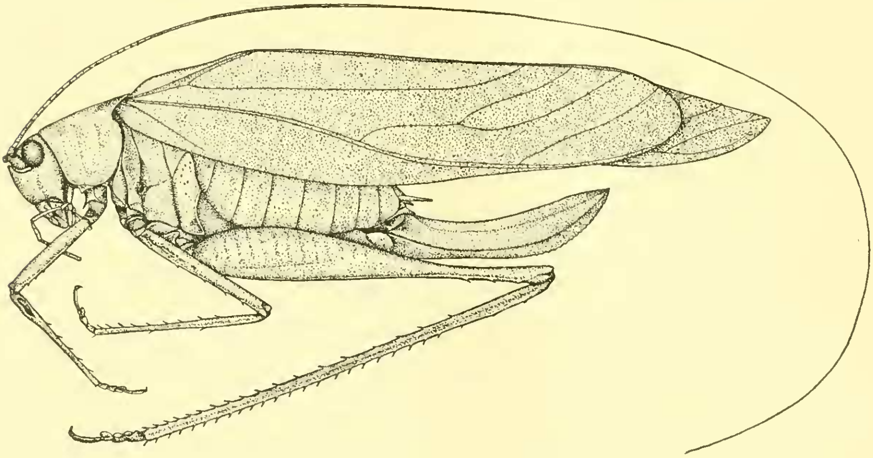

Fig. 10.—*Grammadera rostrata* n. sp. Lateral view of type. (× 2½.)

Size medium; form moderately elongate, distinctly compressed. Head with the occiput, vertex and fastigium on much the same plane, fastigium considerably produced, the margins slightly converging, the apex blunt and extending distinctly beyond the facial fastigium, reaching to the margin of the proximal antennal joint when that portion is in a vertical position, dorsum of the fastigium broadly but not very deeply sulcate; facial fastigium acute, distinctly separated from the fastigium of the vertex; eyes subglobose, prominent; antennæ about three times the length of the body (exclusive of the ovipositor), filiform, proximal joint rather large. Pronotum with the disk flattened only in the caudal section, the cephalic and median sections being rounded into the lateral lobes with a scarcely perceptible median angle, the greatest caudal width being continued about once and a half in the length, cephalic margin of the disk and lateral lobes truncate, caudal margin of the disk arcuate; lateral lobes about as long as deep, humeral sinus broad, shallow, the remainder of the caudal margin gently arcuate, cephalic section of the ventral margin sinuate with the ventro-cephalic angle obtuse. Tegmina about once and a half the length of the body (exclusive of the ovipositor), extending beyond the caudal femora by about the length of the pronotum, lanceolate, the greatest width contained nearly four and a half times in the length, costal margin very slightly arcuate, sutural margin straight in the distal three-fourths, apex rounded; median vein diverging two-fifths the length from the base and furcate with the rami reaching the sutural margin. Wings extending beyond the tegmina a distance nearly equal to the length of the pronotum. Supra-anal plate trigonal, acute; ovipositor about two-fifths the length of the tegmina and slightly more than half that of the caudal femora, moderately arcuate in the distal two-thirds, straight in the proximal third, the greatest width at about the distal third, dorsal margin not sinuate, ventral margin slightly sinuate in the proximal half, apex acute, distal half with the dorsal margin very slightly crenulate, ventral margin distinctly crenulate; subgenital plate short, slightly inflated, the margin with a broad shallow triangular emargination. Cephalic femora about equal to the pronotum in length, armed on the distal section of the ventro-cephalic margin with three spines; median femora slightly longer than the head and pronotum together, armed on the ventro-cephalic margin with three spines. Caudal femora equal to the body in length, considerably inflated distad, ventral margins armed with one or two spines near the apex; tibiæ exceeding the femora by near the length of the pronotum.

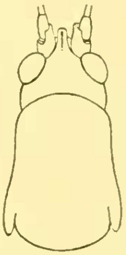

Fig. 11.—*Grammadera rostrata* n. sp. Dorsal view of head and pronotum. (× 4.)

General color maize yellow washed with greenish on the head, pronotum, pleura and limbs; a distinct gamboge yellow line extends from the apex of the fastigium to the caudal margin of the pronotum and is also indicated on the distal portion of the sutural margin of the tegmina; pronotum regularly sprinkled with red-brown dots; eyes vandyke brown; antennæ greenish proximad, yellowish, greenish and blackish distad. Tegmina and wings pale chromium green. Ovipositor with the distal two-fifths paris green, the apex and margins narrowly red-brown. Caudal femora ochraceous on the inflated portion, lined dorsad on the same and with distal section buffy, the whole speckled with red-brown as on the pronotum; caudal tibiæ greenish, much stronger distad.

Measurements.

Length of body (exclusive of ovipositor),	19	mm.
Length of pronotum,	5	"
Length of tegmen,	29.5	"
Length of caudal femur,	18.3	"
Length of ovipositor,	11.5	"

The type is unique.

***Grammadera forcipata** n. sp.

Type: ♂; Sapucay, Paraguay. February 27, 1905. (William Foster.) [Hebard Collection.]

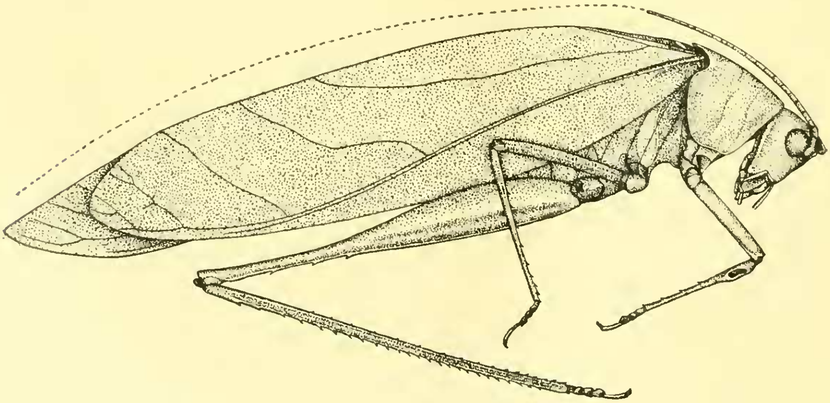

Fig. 12.—*Grammadera forcipata* n. sp. Lateral view of type. (× 3.)

Allied to *G. pellucida* Giglio-Tos, agreeing in the sulcate pronotum and the long slender incurved cerci, but differing in the absence of mucronations on the apex of the cerci, in the longer, strongly divided subgenital plate and the subequally broad as high lateral lobes of the pronotum. There is hardly any possibility of this species being the male of *G. rostrata* as the venation is much more irregular, the fastigium is longer and the limbs shorter and weaker.

Size medium; form considerably compressed. Head with the fastigium much narrower than the proximal joint of the antennæ, subequal, apex blunt, moderately sulcate dorsad, the apex when viewed laterad distinctly exceeding the margin of the proximal antennal joint when the latter is in a vertical position; facial fastigium produced into a slender projecting process directed dorso-cephalad and touching the ventral surface of the apex of the fastigium of the vertex; eyes subglobose, moderately prominent; antennæ slender, broken in the type. Pronotum with the disk as in *G. rostrata* except that the median section bears a distinct longitudinal sulcus more apparent caudad than cephalad, while a rectangulate impressed pattern is placed slightly caudad of the middle; lateral lobes as in *rostrata*. Tegmina about three and a half times as long as the combined length of the head and pronotum, moderately lanceolate, the greatest width contained nearly four times in the length; costal margin regularly but slightly arcuate, sutural margin straight except where it curves to the narrowly rounded apex; median vein diverging very slightly distad of the middle and reaching the sutural margin well before the apex, discoidal vein bearing three rami in the distal section; the whole venation is peculiar in character, the principal veins irregular and connected by numerous adventitious veins. Wings extending beyond the tegmina a distance about equal to the length of the cephalic femora, apex moderately acute. Terminal abdominal segment truncate; supra-anal plate hastate, slightly constricted mesad; cerci simple, tapering, apex acute, the distal section moderately incurved and also with a distinct dorsal curve; subgenital plate strongly produced, reaching about to the end of the cerci, bearing three converging ventral carinæ, narrowly incised distad with the lateral portions of the apex of the plate moderately long, sharp and tapering. Cephalic femora slightly shorter than the pronotum, unarmed ventrad; median femora slightly less than half the length of the caudal femora, unarmed ventrad. Caudal femora very slightly shorter than the body, not strongly inflated proximad, armed with several small spines on the ventro-lateral margin; caudal tibiæ exceeding the femora by nearly the length of the head.

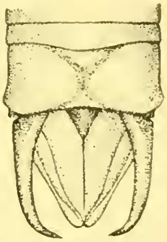

Fig. 13. — *Grammadera forcipata* n sp. Dorsal view of apex of male abdomen. (× 7.)

General color pale chromium green touched with yellowish on the abdomen and proximal portion of the tegmina and somewhat hoary on the pleura, coxæ and lateral lobes of the pronotum. Eyes hazel; tympanum of the tegmina with the principal veins strongly marked with bistre.

Measurements.

Length of body,	17	mm.
Length of pronotum,	4.9	"
Length of tegmen,	27	"
Length of caudal femur,	14.5	"

The type is the only specimen of this species seen by the author.

PHYLLOPTERA Serville.

1831. *Phylloptera* Serville, Ann. Sci. Nat., XXII, p. 142.

Type.—As designated by Kirby, *P. cassinæfolia.*

Phylloptera alliedea Caudell.

1906. *Phylloptera alliedea* Caudell, Proc. U. S. Nat. Mus., XXX, p. 238. [Sapucay, Paraguay.]

February, 1902 and 1905, May, 1902; two males, one female.

Phylloptera spinulosa Brunner.

1878. *Ph[ylloptera] spinulosa* Brunner, Monogr. der Phaneropt., p. 314. [Ypamena, São Paulo, Brazil.]

February, 1905; one male, one female.

The female individual has the tegmina with an ocellus as mentioned by Caudell. In neither specimen are the cephalic tibiæ sulcate dorsad.

The ovipositor of this species is very short and robust, the apex rectangulate, the distal half of the margins crenulate and the faces of the same portion tessellato-granulate. The ventral length of the ovipositor is six millimeters. Subgenital plate small, very strongly produced, divided to the base.

HYPERPHRONA Brunner.

1878. *Hyperphrona* Brunner, Monogr. der Phaneropt., pp. 28, 315.

Type.—*H. angusta* Brunner.

***Hyperphrona signata** n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. December 19, 1904 (♂); February 24, 1905 (♀). (William Foster.) [Hebard Collection.]

Allied to *H. binotata* Brunner from the upper Amazon, agreeing with it in the coloration of the proximal joints of the antennæ, the proportions of the tegmina and the point of contact of the median vein, but differing in the absence of black from the remainder of the antennæ, the spiniform apex of the male cerci, the shorter ovipositor and the peculiar ocelliform marking of the margin of the tympanal field of the male tegmina.

Size rather small; form somewhat compressed. Head with the occiput very slightly rounded, vertex slightly declivent; fastigium trigonal, the margins slightly concave and the apex roundly tuberculate, the proximal portion having the margins roundly elevated and the middle sulcate, when viewed laterad the fastigium is seen to be strongly depressed mesad, with the apex somewhat elevated and not extending cephalad of the proximal joint of the antennæ; facial fastigium acute; eyes subglobose; antennæ half again as long as the greatest length, slender. Pronotum with the disk subdeplanate, laterad with the angles rounded and the greatest caudal width contained once and a half in the length, cephalic margin slightly emarginate, caudal margin strongly arcuate; lateral lobes slightly longer than deep, cephalic margin slightly sinuate, ventral margin rounded obtuse-angulate, caudal margin moderately arcuate with the humeral sinus moderately deep and broad. Tegmina slightly more than three times as long as the head and pronotum together, ovate-lanceolate, the greatest width contained about three and a third times in the length; costal and sutural margins regularly but not strongly arcuate, apex rounded; median vein diverging slightly proximad of the middle, simple or furcate,[4] reaching the sutural margin shortly proximad of the apex; anterior ulnar vein almost straight; tympanum of the male with the stridulating vein very stout. Wings extending beyond the tegmina a very short distance, narrowly rounded

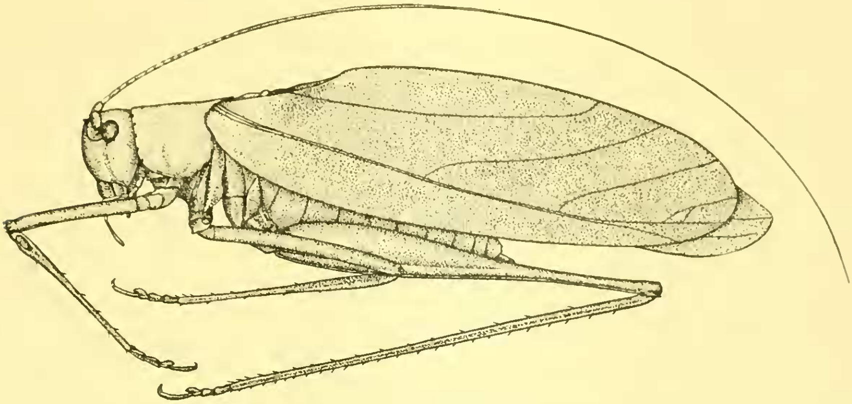

Fig. 14.—*Hyperphrona signata* n. sp. Lateral view of male type. (× 3.)

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[4] In the types furcate only on the left tegmen of the female.

at the apex. Terminal dorsal abdominal segment of the male with a very slight and broad median emargination; supra-anal plate reflexed, roughly semicircular; cerci stout at the base, short, tapering, the tips moderately hooked, acute; subgenital plate moderately produced, the apical portion much narrower than the base, apical margin truncate, false styles short and dentiform. Ovipositor about as long as the pronotum and half of the head, bent arcuate, broad, apex moderately acute, distal half of the dorsal margin distinctly crenulate, of the ventral margin obsoletely crenulate; subgenital plate small, rectangulate with the apex minutely rectangulate emarginate. Cephalic femora but little shorter than the head and pronotum together, unarmed; dorso-caudal margin of the tibiæ with four to five spines, one of which is placed at the distal extremity of the proximal inflation. Median femora equal to about half the length of the caudal femora, armed on the ventro-cephalic margin with two to three small, recumbent spines. Caudal femora slightly shorter than the length of the body, moderately inflated distad and with spines none or one on the ventro-cephalic margin; caudal tibiæ distinctly exceeding the femora.

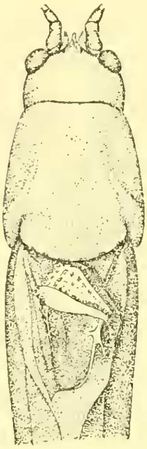

Fig. 15.—*Hyperphrona signata* n. sp. Dorsal view of head, pronotum and tympanum of male type. (× 5.)

General color buff-yellow becoming apple green on the tegmina, exposed portion of the wings and limbs. Eyes chestnut; antennæ very broadly and irregularly annulate with dragon's blood red. Pronotum with the disk regularly and the lateral lobes sparingly dotted with dragon's blood red, the margins being rather regularly checked with the same.

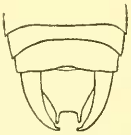

Fig. 16.—*Hyperphrona signata* n. sp. Dorsal view of apex of male abdomen. (× 6.)

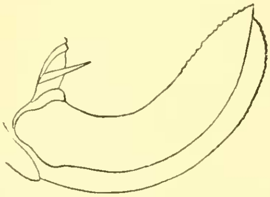

Fig. 17.—*Hyperphrona signata* n. sp. Lateral view of ovipositor. (× 5.)

Tegmina sometimes[5] with an ochraceous premedian desiccated spot, margined on all but the caudal face with brown; tympanum of the male with an irregular median blotch of very pale greenish surrounded by a very irregular ring of liver brown; sutural margin narrowed touched mesad with liver brown.

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[5] On the left tegmen of the female type.

Measurements.

	♂	♀
Length of body (exclusive of ovipositor),	17.3 mm.	18.3 mm.
Length of pronotum,	4.3 "	4.3 "
Length of tegmen,	23.2 "	21 "
Length of caudal femur,	17 "	16 "
Length of ovipositor,		5.5 "

A series of four male and six female paratypic individuals have also been examined. The months represented in the series are December, 1904, and January, February and March, 1905.

In size there is an appreciable amount of variation, in addition to which there also appears to be two forms irrespective of sex, one with the tegmina short as in the female type, the other with the tegmina longer and correspondingly slenderer as in the male type. The series also shows that the forking of the median vein is purely a variation not even individual, one tegmen in a number of specimens having the unbranched type, the other the reverse. The female type is the only specimen with the premedian tegminal spot, while the tympanal spot of the male with its surrounding ring is also seen to vary greatly in depth, though always present in that sex. In a number of specimens the tegmina are distinctly yellow proximad, and in one male the whole tegmina are of that color.

TURPILIA Stål.

***Turpilia paraguayensis** n. sp.

Types: ♂ and ♀; March 12 (♀) and 21 (♂), 1905. (William Foster.) [Hebard Collection.]

Closely allied to *T. mexicana* Brunner from Oaxaca and *T. linearis* Rehn from Costa Rica. From *mexicana* it differs in the general smaller size, the spined dorsal margin of the median femora and the acute subgenital plate of the femora. From *linearis* it differs in the lateral lobes of the pronotum being as long as deep, the tegmina slightly shorter and the cerci with a distinct apical spine.

Size moderately large; form elongate. Head with the occiput slightly rounded; fastigium strongly compressed, narrowly sulcate, apex blunt, separated from the blunt apex of the acute angulate facial fastigium by a very slight space; eyes large, subglobose, moderately prominent; antennæ probably exceeding the tips of the wings (slightly defective in the types), filiform. Pronotum with the disk strongly deplanate, slightly expanding in width caudad, the greatest caudal width contained slightly less than once and a half in the length; cephalic margin truncate, caudal margin arcuate, lateral angles distinct but narrowly rounded, a fine impressed longitudinal median line present on the disk; lateral lobes about as long as deep, ventro-cephalic angle very broadly rounded, humeral sulcus marked but shallowly, the caudal margin ventrad of this with a rounded obtuse angle from which the ventro-caudal margin is diagonally subtruncate. Tegmina elongate lanceolate, about four times as long as the combined length of the head and pronotum, the greatest width contained nearly five times in the length; costal and sutural margins slightly approximating, the apex rounded; discoidal vein with two rami in the distal section, both of which reach the apical margin; median vein diverging two-fifths the distance from the base, furcate. Wings extending beyond the tegmina a distance very nearly equal to the length of the pronotum, immediate apex rectangulate. Terminal dorsal abdominal segment of the male broadly and shallowly emarginate mesad and also on the lateral faces; cerci short, stout at the base, tapering, with the immediate apex sharply narrowed, hooked and spiniform, internal margin slightly before the middle provided with a thick, blunt, peg-like process; subgenital plate of the male produced, narrowed with a median ventral carina and lateral thickened rods which extend to the base of the short, slender styles, narrow distad margin of the plate with a rounded V-shaped emargination. Ovipositor as long as the head and half of

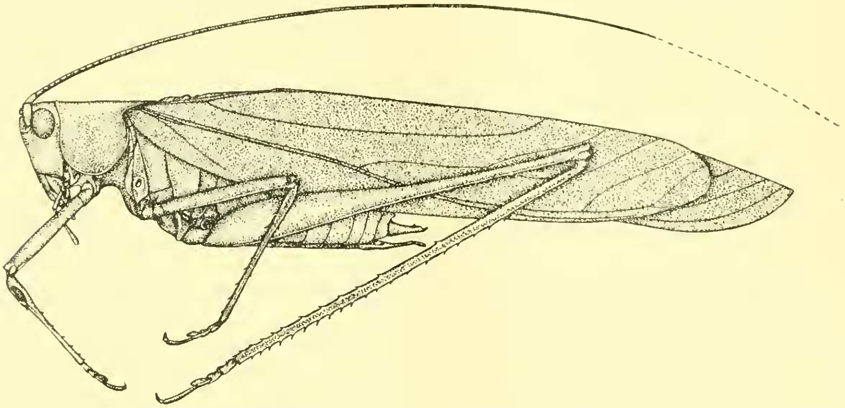
Fig. 18.—*Turpilia paraguayensis* n. sp. Lateral view of male type. (× 2½.)

the pronotum, considerably bent proximad, very slightly curved distad, the greatest width mesad and contained two and one-half times in the length, dorsal margin nearly straight and entirely crenulate, ventral margin considerably arcuate and crenulate in the distal fourth, apex slightly narrowed, rounded; subgenital plate of the female produced trigonal with slightly concave sides, apex narrowly truncate. Cephalic femora about equal to the pronotum in length, unarmed ventrad; the proximal inflation of the tibiæ supplied with a distal spine on the caudal margin. Median femora as long as the head and pronotum together, unarmed ventrad. Caudal femora about equal to the body in length, moderately inflated proximad, ventro-lateral margin with three to five spines distad, internal margin with six to seven spines; caudal tibiæ slightly longer than the femora.

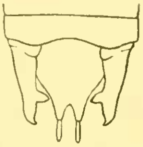

Fig. 19.—*Turpilia paraguayensis* n. sp. Dorsal view of apex of male abdomen. (× 6.)

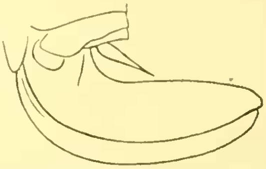

Fig. 20.—*Turpilia paraguayensis* n. sp. Lateral view of ovipositor. (× 5.)

General color dull greenish-yellow, the tegmina and wings apple green. Head with the eyes chestnut, antennæ with all except the two proximal joints vinaceous-cinnamon; pronotum with the caudal section of the disk apple green, the lateral angles sometimes marked with vinaceous; tegmina with the anal vein and sutural margin more or less distinctly marked with buff-pink; tibial foramina marked with dark brown, distal extremities of the tibiæ and the tarsi ochraceous buff; ovipositor orange-rufous.

Measurements.

	♂	♀
Length of body,	20 mm.	22.7 mm.
Length of pronotum,	5 "	5.5 "
Length of tegmen,	31 "	31.2 "
Length of caudal femur,	20.8 "	21.8 "
Length of ovipositor,		6.5 "

A paratypic series of five males and five females, taken in March, 1903, have also been examined and found to differ in no important characters from the type.

MICROCENTRUM Scudder.

***Microcentrum lanceolatum** (Burmeister).

1838. *Ph[ylloptera] lanceolata* Burmeister, Handb. der Entom., II, Abth. II, pt. I, p. 692. [Brazil.]

March, 1905; one female.

This individual is rather smaller than the Brazilian or Surinam material measured by Brunner,[6] but otherwise it is perfectly typical of the species.

Measurements.

Length of pronotum,	6.5 mm.
Length of tegmen,	42 "
Greatest width of tegmen,	13.5 "
Length of caudal femur,	22.2 "
Length of ovipositor,	6 "

This species has been recorded from Villa Rica, Paraguay, and Urucum, Matto Grosso, Brazil, by Giglio-Tos.

PSEUDOPHYLLINÆ.

DASYSCELUS Brunner.

1895. *Dasyscelus* Brunner, Monogr. der Pseudophyll., pp. 15, 118.

Type.—*D. atrifrons* Brunner.

Dasyscelus normalis Brunner.

1895. *Dasyscelus normalis* Brunner, Monogr. der Pseudophyll., p. 119. [Uruguay; Buenos Ayres.]

November, December and January, 1903 and 1905, April, 1903; six males, twelve females.

This species appears to have as a synonym *D. demigratus* Brunner, over which *normalis* has line priority. The differences cited are in the color of the face and in the length of the tegmina and limbs. The former of these characters is at once discredited by the fact that two types, one with a black face and the other with a pale face, are present in this series, the two extremes being connected by a number of intermediates. The length of the limbs varies with the general size and the present series shows more difference in size in the extremes than the typical measurements of *normalis* and *demigratus*, although the Sapucay individuals average larger than Brunner's material, which came in part at least from Buenos Ayres. The original localities given for *demigratus* are "Gabun, Buenos Ayres," but the former is unquestionably erroneous.

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[6] *Monogr. der Phaneropt.*, p. 336.

CONOCEPHALINÆ.

LAMNICEPS Bolivar.

1903. *Lamniceps* Bolivar, Revista Chilena de Hist. Nat., VII, núm. 3, p. 144

Type.—*L. giglio-tosi* Bolivar.

***Lamniceps giglio-tosi** Bolivar.

1903. *Lamniceps Giglio-Tosi* Bolivar, Revista Chilena de Hist. Nat., VII, núm. 3, p. 145. [Central Paraguay.]

November and December, 1904, February, 1905; four females.

These individuals are perfectly typical of Bolivar's genus and species, which is clearly, as stated by him, intermediate in position between *Copiphora* and *Lirometopum*.

One specimen is slightly smaller than the others, but otherwise no differences are noted.

The description of *Copiophora borellii* Giglio-Tos[7] appears to be that of a form closely related to this species.

CONOCEPHALOIDES Perkins.[8]

1899. *Conocephaloides* Perkins, Fauna Hawaiiensis, Orth., p. 13.

Type.—*C. hawaiiensis* Perkins = *Conocephalus remotus* Walker.

***Conocephaloides ichneumoneus** (Bolivar).

1884. *Conocephalus ichneumoneus* Bolivar, Artópod. Viaje al Pacífico, Neuropt. y Ortópt., p. 90, lám. 2, fig. 10. [Apiahy, Brazil.]

December, 1904; two females.

This specimen fully agrees with Bolivar's description, except that the pronotum and tegmina are very slightly longer and the ovipositor slightly shorter.

The type locality in the State of São Paulo and this record constitute the known localities for the species.

***Conocephaloides pichinchæ** (Bolivar).

1881. *Conocephalus Pichinchœ* Bolivar, Anales Soc. Españ. Hist. Nat., X, p. 498. [Pichincha, Ecuador.]

November, 1904; one male.

This individual is referred here with considerable doubt, but it is clearly related to this species and *guttatus*, with a number of which latter species it has been compared. From the original description of *pichinchæ* it differs in its apparently broader tegmina, its unarmed cephalic femora and slightly longer caudal femora. The tibiæ bear the very apparent distal blackish-fuscous markings originally described.

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[7] *Bollett. Mus. Zool. Anat. Comp. Torino*, IX, No. 184, p. 40. [Luque, Paraguay.]

[8] The author is compelled with considerable reluctance to adopt this name, based on an aberrant form of the genus, in preference to the familiar application of *Conocephalus* Thunberg. After examining the literature involved it is evident, as has been shown by Kirby (*Synonym. Catal. Orthopt.*, II, pp. 241, 274 and 279), that Thunberg's *hemipterus* is identical with *Gryllus conocephalus* Linnæus, which by the rule of tautonomy is the type of *Conocephalus* Thunberg. The latter genus, however, is not cancelled by the fact that it is based on a specific name, as Kirby so treats it, but instead it replaces *Anisoptera* Latreille and *Xiphidion* Serville.

Conocephaloides pustulatus (Redtenbacher).

1891. *Conocephalus pustulatus* Redtenbacher Verhandl. K.-K. Zool.-botan. Gesell. Wien, XLI, p. 395. [Theresopolis, Brazil.]

November and December, 1904, January, 1905; seven males, five females.

This series shows a moderate amount of variation in size, chiefly in the length of the tegmina. Both color phases are in the series at hand, the green, however, predominating.

Kirby has recently[9] applied the name *exaltatus* Walker[10] to this species, but Walker's description does not agree in several details with the material before us and Redtenbacher's diagnosis perfectly characterizes the species. In consequence we prefer to use Redtenbacher's name for the Paraguayan and south Brazilian form until its relationship to Walker's species is more clearly understood.

***Conocephaloides maxillosus** (Fabricius).

1794. *Locusta maxillosa* Fabricius, Entom. Syst., II, p. 37. [America.]

March, 1905; one female.

The range of this species to the south now appears to be limited by southern Brazil (Rio Janeiro, Theresopolis), Paraguay and Bolivia.

***Conocephaloides maculosus** (Redtenbacher).

1891. *Conocephalus maculosus* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 396. [Lages, Santa Catharina, Brazil.]

December, 1904; one male.

This individual differs somewhat in its measurements from the original female type, but such differences may be sexual, and as far as can otherwise be determined from the original description it represents this species. The measurements may be of interest:

Length of body,	27.5 mm.
Length of pronotum,	8.1 "
Length of tegmen,	37.5 "
Length of caudal femur,	21.5 "

***Conocephaloides saturatus** (Griffini).

1891. *Conocephalus infuscatus* Redtenbacher (not of Scudder, 1875), Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 398. [Medellin; St. Vincent, Lesser Antilles; Cuba; Venezuela; Surinam; Cayenne; Brazil; Rio Grande and Theresopolis, Brazil; Peru.]

1899. *Conocephalus saturatus* Griffini, Miscell. Entom., VII, p. 5.

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[9] *Synon. Catal. Orth.*, II, p. 243.

[10] *Catal. Derm. Salt. Brit. Mus.*, II, p. 311. [Venezuela.]

March, 1905; three females.

In these specimens the length of the tegmina varies from 33 to 38 millimeters, the caudal femora from 24 to 25.5 and the ovipositor from 34 to 34.5. The ovipositor is appreciably longer than the measurements given by Redtenbacher (26–28 mm.), but otherwise the specimens are perfectly typical.

***Conocephaloides brachypterus** (Redtenbacher).

1891. *Conocephalus brachypterus* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 400. [Brazil.]

February, 1903; one female.

This individual has several spines on each of the cephalic and median femora, but otherwise it fully agrees with the original description.

***Conocephaloides rugosicollis** (Bolivar).

1881. *Conocephalus rugosicollis* Bolivar, Anales Soc. Españ. Hist. Nat., X, p. 496. [Huasco, Chile.]

November and December, 1904, January, February and March, 1905; seven males, six females.

As far as can be determined from the several published descriptions of this species the Paraguayan series before us is referable to *rugosicollis*. In the degree of contiguity of the vertex and frontal fastigium there is, however, considerable variation, ranging from individuals with the two distinctly touching to others in which they are slightly but appreciably separated. In no other character, however, can the material be separated, and the majority of the series is rather intermediate between the two.

The figure of the tegmen given by Redtenbacher[11] is not exactly as seen in the Paraguayan specimens, as the obliquely truncate apex of the tegmen is not sinuate in the latter series.

As the female of this species has never been described a few notes may be of interest.

Ovipositor less than half the length of the tegmina, slightly bent proximad, straight otherwise, thick distad, the greatest width at about a fourth the length from the apex, latter acute; subgenital plate with a deep median sinuate V-shaped emargination.

Measurements.

Length of body (exclusive of ovipositor),	31	mm.
Length of pronotum,	7.9	"
Length of tegmen,	41	"
Length of caudal femur,	24.2	"
Length of ovipositor,	18.3	"

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[11] *Verhandl. K.-K. Zool.-bot. Gesell. Wien*, XLI, taf. III, fig. 44.

AGRÆCIA Serville.

1831. *Agræcia* Serville, Ann. Sci. Nat., XXII, p. 152.

Type.—*Locusta punctata* Serville.

***Agræcia maculata** Redtenbacher.

1891. *Agræcia maculata* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 455, taf. IV, fig. 63. [Theresopolis, Brazil.]

November and December, 1904; nine males, eleven females.

These individuals are perfectly typical of the species except for their smaller size. Considerable variation in size is noticed in the female sex, but no specimen is as large as the measurements given by Redtenbacher.

The cerci of the male are short, stout and with the apex abruptly tapering; subgenital plate with the apex broad, truncate and with considerable sized lateral false styles.

The measurements of an average male and the extremes of the female sex are here given:

	♂	♀	♀
Length of body,	26 mm.	28.5 mm.	33.5 mm.
Length of pronotum,	7 "	7 "	7.6 "
Length of tegmen,	31 "	30.5 "	36.5 "
Length of caudal femur,	16.5 "	17.2 "	18.5 "
Length of ovipositor,		14.5 "	15.7 "

XIPHELIMUM Caudell.

1906. *Xiphelimum* Caudell, Proc. U. S. Nat. Mus., XXX, p. 241.

Type. *X. amplipennis* Caudell.

Xiphelimum amplipennis Caudell.

1906. *Xiphelimum amplipennis* Caudell, Proc. U. S. Nat. Mus., XXX, p. 241. [Sapucay, Paraguay.]

March, 1905; seven males.

These specimens fully agree with the original description of this beautiful species.

CONOCEPHALUS Thunberg.[12]

1815. *Conocephalus* Thunberg, Mém. l'Acad. Imp. Sci. St. Pétérsb., V, pp. 214, 271.

Type by tautonomy *C. hemipterus* Thunberg = *Locusta conocephalus* Linnæus.

1831. *Xiphidion* Serville, Ann. Sci. Nat., XXII, p. 159.

Conocephalus longipes (Redtenbacher).

1891. *Xiphidium longipes* Redtenbacher, Verhandl. K.-K. Zool.-bot. Gesell. Wien, XLI, p. 505, taf. IV, fig. 81. [Buenos Ayres, Argentina; Montevideo, Uruguay; Rio Grande do Sul and Santa Catharina, Brazil; Peru(?).]

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[12] See note on page — under *Conocephaloides*.

March, 1905: one male.

This specimen has been compared with a pair from Carcarañа, Argentina.

Conocephalus saltator (Saussure).

1859. *Xiphidium saltator* Saussure, Revue et Magasin de Zoologie, 2e ser XI, p. 208. [Guiana.]

March, 1905: one male, four females.

The ovipositor is practically straight in all the females and about thirteen millimeters in length.

The species ranges from Cuba to Montevideo, Uruguay.

Conocephalus strictoides (Caudell).

1906. *Xiphidium strictoides* Caudell, Proc. U. S. Nat. Mus., XXX, p. 242. [Sapucay, Paraguay.]

April, 1902: one female.

This specimen has the tegmina, caudal femora and ovipositor somewhat smaller than in the type measurements, but in all other characters the individual agrees perfectly with the original description, except that the dorsum of the abdomen is marked in purplish brown with a pattern resembling that of *C. strictum*.

GRYLLACRINÆ.

CAMPTONOTUS Uhler.

1864. *Camptonotus* Uhler, Proc. Entom. Soc. Phila., II, p. 548.

Type.—*C. scudderi* Uhler (= *Gryllacris carolinensis* Gerstaecker).

***Camptonotus australis** n. sp.

Types: ♂ and ♀; Sapucay, Paraguay. November 10 (♂) and December 19 (♀), 1905. (William Foster.) [Hebard Collection.]

Allied to *C. carolinensis* (Gerstaecker) and *affinis* Rehn, but differing from both in the very robust caudal femora and the heavy, more regularly arcuate and less attenuate ovipositor.

Size medium; form as usual in the genus; surface glabous. Head with the occiput well arched, longitudinally and transversely; vertex very broad and evenly rounding into the front; face somewhat flattened; eyes elongate reniform; antennæ about four times as long as the body. Pronotum with the dorsal length slightly shorter than the greatest width, the dorsal outline when viewed laterad slightly convex; cephalic margin of the disk truncate, caudal margin very broadly and shallowly triangular emarginate; lateral lobes broadly rounding into the disk, longer than deep, ventral margin truncate, ventro-cephalic angle obliquely rounded, ventro-caudal angle obliquely subtruncate. Mesonotum and metanotum with their caudal margins very slightly arcuate. Abdomen somewhat compressed; terminal dorsal abdominal segment of the male moderately inflated, the apical margin rotundate emarginate, a median longitudinal carina present on the distal half; male cerci simple, terete, acute, the length about equal to that of the terminal abdominal segment; subgenital plate of the male short; apical margin obtuse-angulate emarginate; ovipositor nearly equal to half the length of the body, regularly arcuate, moderately stout proximad and regularly tapering to the acute apex; subgenital plate of the female broad trigonal, apex narrowly and shallowly emarginate. Cephalic and median limbs moderately robust. Caudal femora nearly two and a half times the length of the pronotum, strongly inflated, the greatest width contained nearly two and a half times in the length, ventro-lateral margin with three to four spines, internal margin armed distad with two spines; tibiæ not exceeding the femora in length.

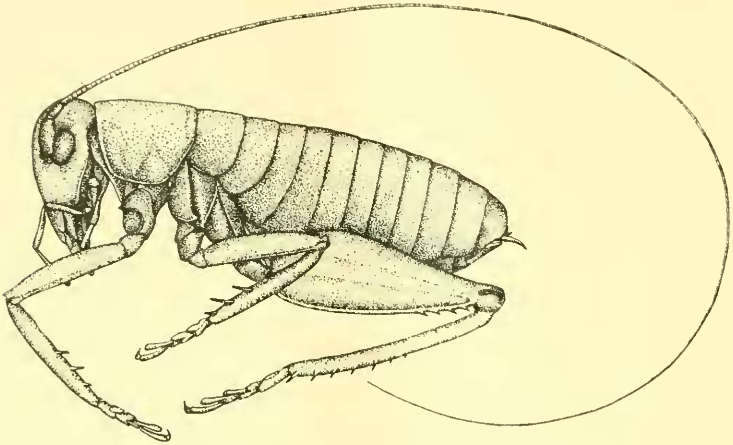

Fig. 21.—*Camptonotus australis* n. sp. Lateral view of male type. (× 4.)

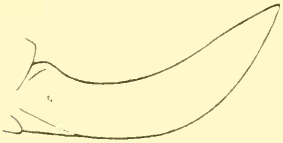

Fig. 22.—*Camptonotus australis* n. sp. Lateral view of ovipositor. (× 5.)

General color ochraceous becoming buffy on the limbs, particularly the caudal tibiæ which also have a faint wash of green distad. Eyes bistre.

Measurements.

	♂	♀
Length of body,	13.5 mm.	16 mm.
Length of pronotum,	3.2 "	3.3 "
Length of caudal femur,	7.3 "	8.9 "
Length of ovipositor,		7 "

A paratypic series of four males and three females, taken November, 1904, have also been examined. Aside from a considerable amount of variation in size no differences worthy of note are apparent.

GRYLLIDÆ.

GRYLLOTALPINÆ.

SCAPTERISCUS Scudder.

Scapteriscus camerani Giglio-Tos.

1894. *S[capteriscus] Camerani* Giglio-Tos, Bollett. Mus. Zool. Anat. Comp. Torino, IX, No. 184, p. 45, plate figs. 13 and 16. [Province of San Pedro, Asuncion, Paraguay.]

January, 1903; one female.

This individual is slightly smaller than the original measurements for the same sex, but otherwise is perfectly typical.

GRYLLINÆ.

GRYLLUS Linnæus.

Gryllus assimilis (Fabricius).

1775. *Acheta assimilis* Fabricius, Syst. Entom., p. 280. [Jamaica.]

February, 1905; one male, three females.

These specimens are much paler than Mexican individuals of this species, three of them being especially light in color.

Gryllus argentinus Saussure.

1874. *Gryllus Argentinus* Saussure, Miss. Scientif. au Mex. et l'Amér. Cent., Orth., p. 399. [Southern Brazil; Argentine Republic; the north of Patagonia; Buenos Ayres; Bahia Blanca; Rio Negro of Patagonia.]

July, 1902, February and March, 1905; two males, two females.

These specimens agree very well with an authentic pair of this species from Buenos Ayres and Rio Grande do Sul, Brazil, received from Dr. Saussure.

ENEOPTERINÆ.

ENEOPTERA Burmeister.

1838. *Eneoptera* Burmeister, Handb. d. Entom., II, Abth. II, pt. I, p. 736.

Type.—*Acheta brasiliensis* Fabricius (= *Gryllus surinamensis* De Geer).

Eneoptera surinamensis (De Geer).

1773. *Gryllus Surinamensis* De Geer, Mém. Ins., III, p. 519, pl. 43, fig. 1 [Surinam.]

March, 1905; three males, two females.